

POSTER WORLD RIVERS • WATER FOOTPRINT

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NATIONAL GEOGRAPHIC

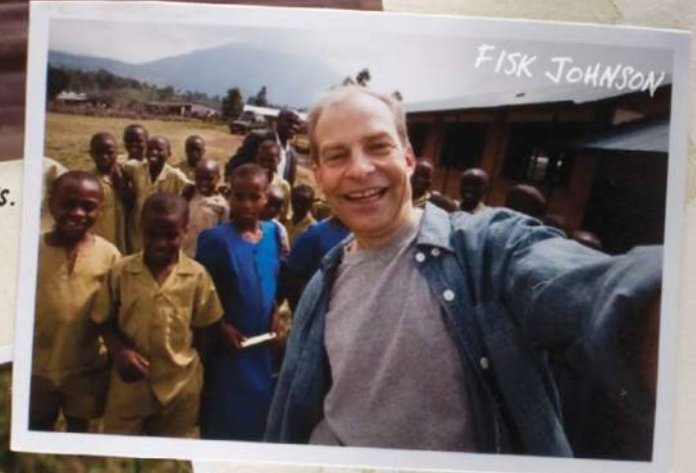
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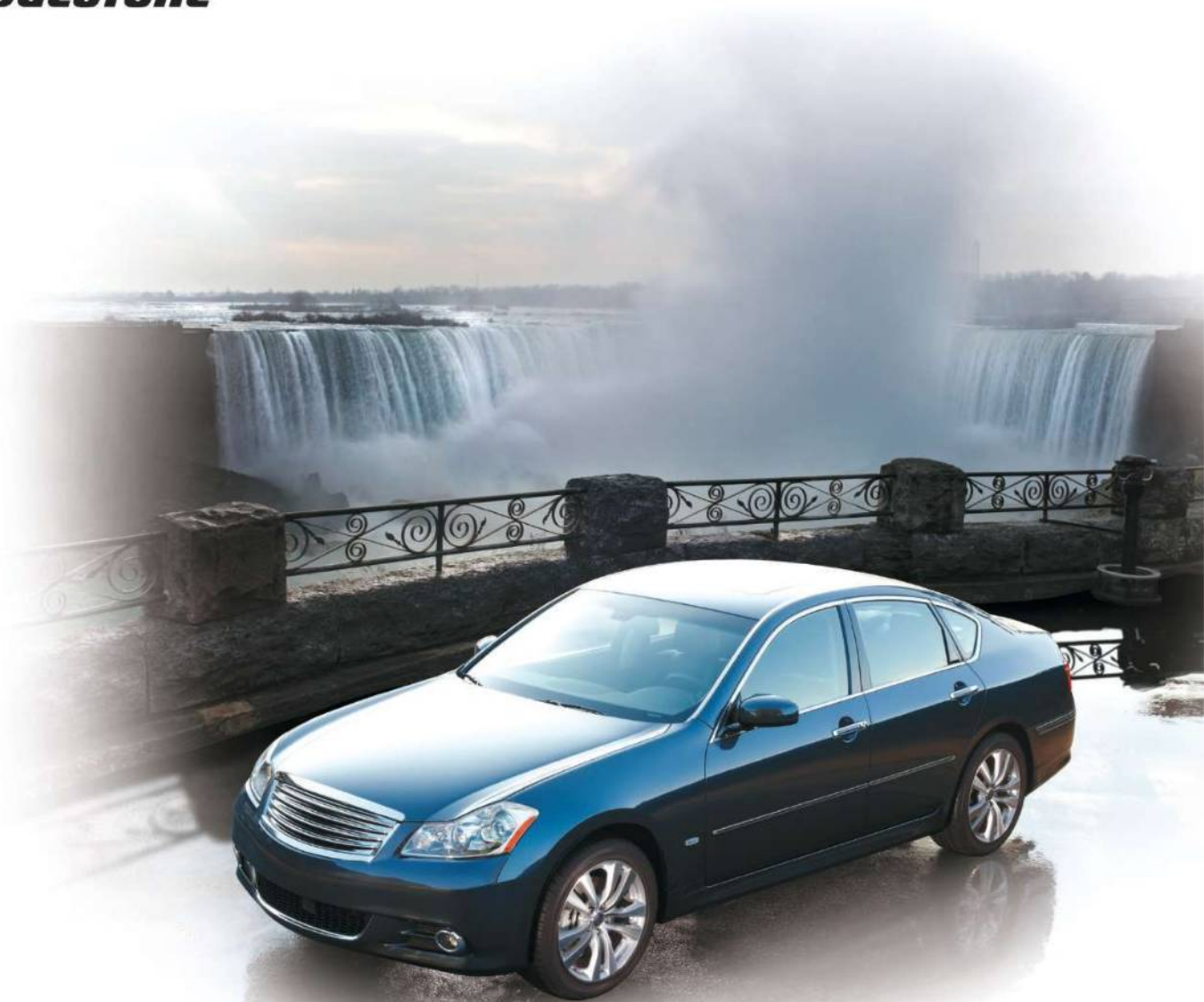


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NATIONAL GEOGRAPHIC

APRIL 2010 • VOL. 217 • NO. 4

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Special Supplement: World Rivers/Water Footprint



RAJANISH KAKADE, AP IMAGES

The power of water is evident in this Hindu ritual. Last August a holy man in Mumbai immersed himself for four hours to pray for rain.

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It takes more than a financial company to save something this precious.

At Royal Bank of Canada, we have a long-standing commitment to environmental sustainability. Water has become an integral part of that commitment, as it is fundamental to the sustainability of all life. However, the water challenges facing the world represent a serious humanitarian crisis in developing nations, as well as a growing economic challenge for all nations. That's why we created the RBC Blue Water Project™, a \$50 million grant program to support charitable organizations around the world that foster a culture of water stewardship.

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RBC Blue Water Project™

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IMAGINE H2O | www.imagineh2o.org

Imagine H2O is committed to turning water problems into opportunities. This program serves as a launch pad for water innovation by helping entrepreneurs turn great ideas into great businesses. With the help of RBC, Imagine H2O hosts an annual prize competition that offers cash prizes and a business incubator to promising water entrepreneurs. Through these annual competitions, Imagine H2O is creating a global ecosystem for water innovation that unites entrepreneurs, investors, governments and social enterprise.

NATIONAL GEOGRAPHIC | www.nationalgeographic.com/freshwater

The RBC Blue Water Project is a founding partner of the National Geographic Freshwater Initiative, a multi-year project that coordinates across sectors to inspire, educate and empower individuals and communities to conserve freshwater and the extraordinary diversity of the life it sustains. RBC is extending its relationship with the National Geographic Society by sponsoring additional fresh water education programs throughout 2010.

ONE DROP FOUNDATION | www.ONEDROP.org

RBC's inaugural Visionary Grant was to the ONE DROP Foundation, an organization established by Cirque du Soleil® founder Guy Laliberté. The RBC Blue Water Project grant allows the organization to support initiatives that improve water access and increase education about the value and vulnerability of the world's freshwater resources. This includes \$1 million to help provide access to water and sanitation to the people of Haiti and rebuild small water and sanitation infrastructure damaged in January's devastating earthquake.

JAMES RIVER ASSOCIATION | www.jamesriverassociation.org

The RBC Blue Water Project grant helps JRA build awareness and rally citizens from Richmond, Virginia to the Allegheny Mountains to protect America's Founding River from polluted runoff.

UPPER CHATTAHOOCHEE RIVERKEEPER | www.chattahoochee.org

The RBC Blue Water Project is helping fund "No Time To Waste," an outreach campaign that will educate citizens about the causes of metro Atlanta's ongoing water crisis and what they can do to conserve water, be energy efficient and promote sustainable land use.

DONORSCHOOSE.ORG | www.donorschoose.org

It is increasingly common for teachers to spend their own money on classroom materials, especially in rural and disadvantaged inner city communities. The RBC Blue Water grant helps public school teachers all across the United States obtain classroom supplies for projects dealing with water.

To learn more about the various projects RBC supports, visit rbc.com/bluewater.



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Project™**

NATIONAL GEOGRAPHIC

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GEOGRAPHY

Journey to the Bottom of the Spigot

In every country, there's a different story about how water reaches the faucet.

HEALTH

Wash Away Germs

Scrubbing with soap for at least 20 seconds could save millions of lives.

SPACE

Water's Out There

The closer we look, the more water and ice we discover beyond Earth.

TECHNOLOGY

Big Dipper

The world's largest pool has white sand, sailboats, and 66 million gallons of water.

SCIENCE

Up a Slippery Slope

The same energy that clumps cereal together in milk helps a bug scale a watery curve.

THE BIG IDEA

Get the Salt Out 32

Desalination plants will soon add billions of gallons a day to the drinking supply.

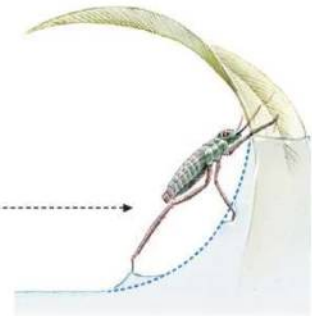
Inside Geographic 178

Flashback

GeoPuzzle

On the Cover

Drops spritzed from a spray bottle landed on Formica for their close-up.
Photo by Mark Thiessen



Special Thanks

The magazine thanks the Howard G. Buffett Foundation, the Honorable Marilyn Ware, and the members of the National Geographic Society for their generous support of this issue. It is also grateful to the many NGOs and experts who shared their frontline knowledge of the water crisis with us.

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EDITOR'S NOTE



In Shakana, Ethiopia, Halike Berisha must fill her water jug from a contaminated reservoir.

As a chemical compound, nothing could be simpler than water: two atoms of hydrogen joined to one of oxygen. From a human point of view, simplicity fades. Though water covers our world, more than 97 percent is salty. Two percent is fresh water locked in snow and ice, leaving less than one percent for us. This “precarious molecular edge on which we survive,” as Barbara Kingsolver says in this month’s special issue, will only grow more precarious. By 2025, 1.8 billion people will live where water is scarce.

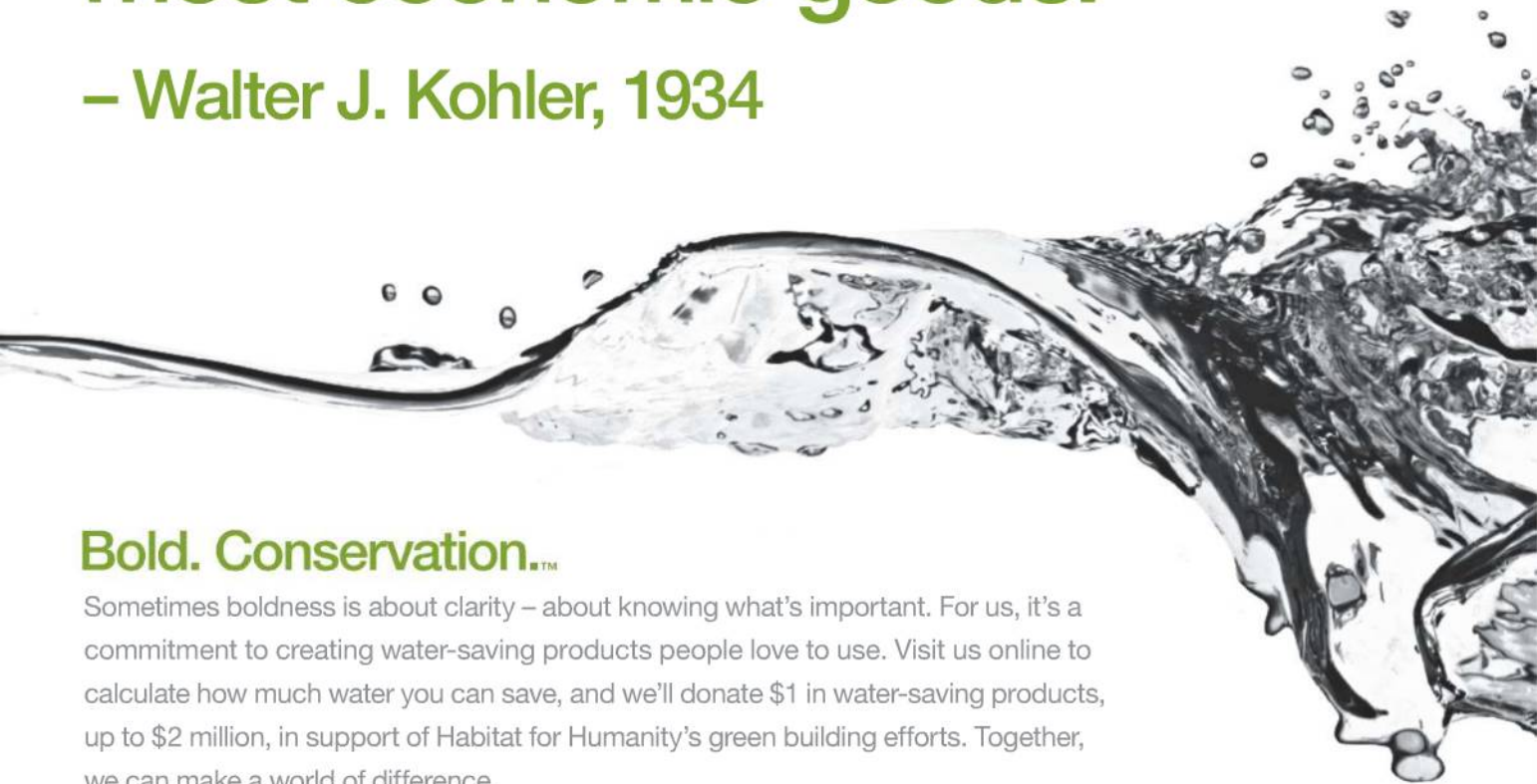
In the pages to come, we bring to life the drama behind that statistic. And this is only the start of a larger commitment, at the magazine and throughout the National Geographic Society, to explore the world of water. To that end, the Society recently named Sandra Postel its first National Geographic Freshwater Fellow. As a researcher, lecturer, and writer, Sandra has worked in the field of sound water management for 25 years. The initiative she heads will not only educate; it will “reshape how people and communities think about, use, and manage fresh water. It will provide the tools to enable individuals, corporations, and communities to become part of the solution,” Sandra says.

Through the National Geographic website we’ll provide information, interactive tools, and success stories. We’ll raise awareness through films, books, and presentations. Our goal is to lead a far-reaching effort to meet the challenges posed by this precious and finite resource.

A handwritten signature in black ink, appearing to read "Chris Jones".

So-called “free goods”
such as sunshine and
fresh air may be of
more real worth than
most economic goods.

– Walter J. Kohler, 1934



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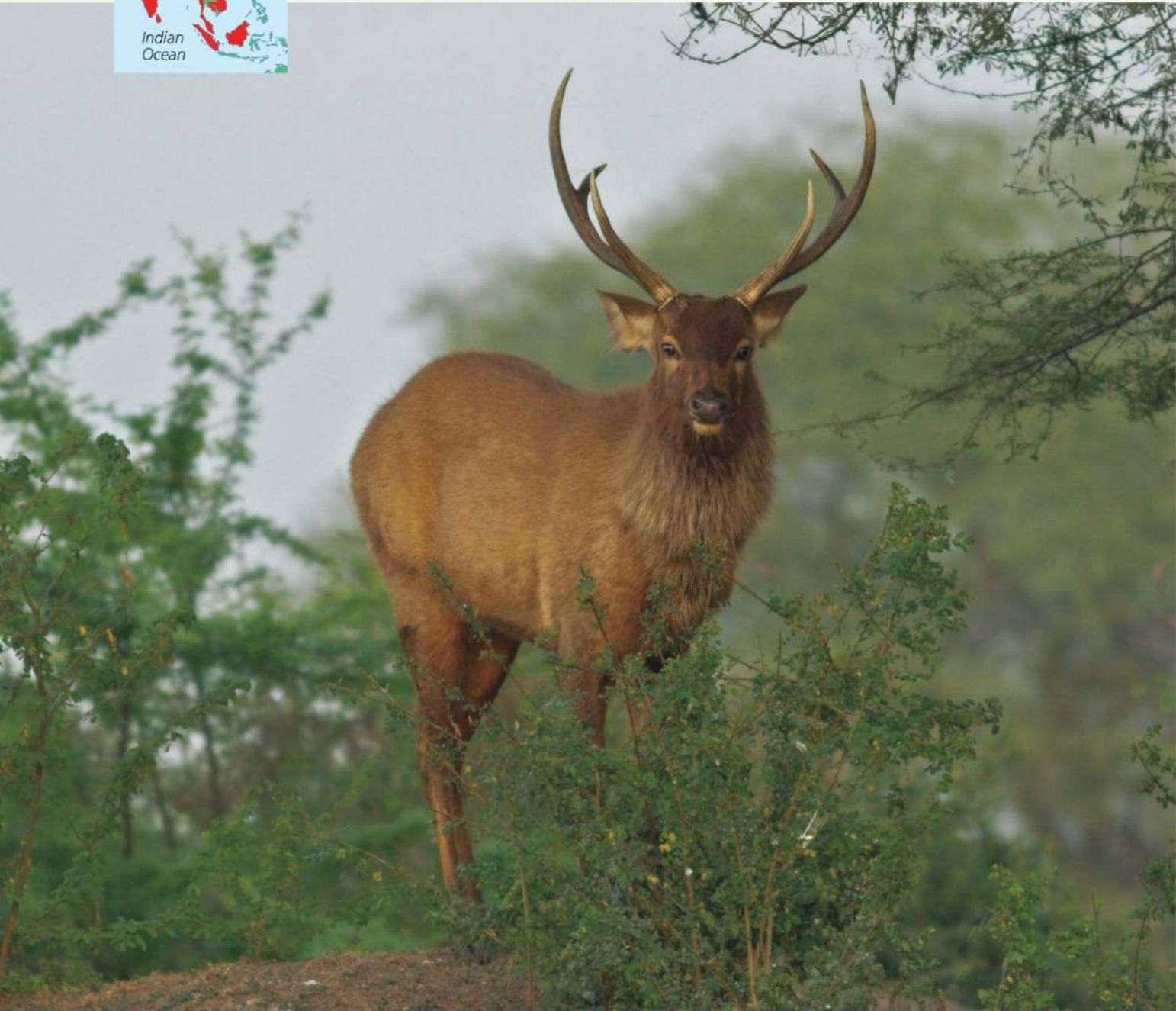
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Sambar Deer (*Rusa unicolor*)

Size: Head and body length, 162 - 246 cm (63.8 - 96.9 inches); shoulder height, 102 - 160 cm (40.2 - 63 inches); tail, 25 - 30 cm (9.8 - 11.8 inches) **Weight:** 109 - 260 kg (240.3 - 573.2 lbs) **Habitat:** Ranges from thorn and arid forests to deciduous and evergreen forests **Surviving number:** Unknown; populations declining



Photographed by Lee Dalton

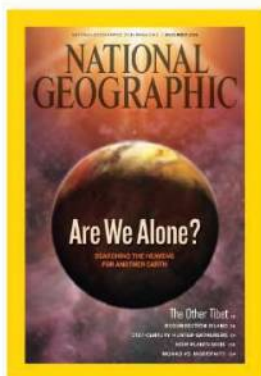
WILDLIFE AS CANON SEES IT

Picky? Not at all. The sambar deer's diet encompasses many varieties of plant, over 100 in India alone. This is one key to the deer's great adaptability, allowing it to live in a wide range of habitats at varying elevations. Depending on where it is, it may stick to foraging in small family groups or congregate in numbers of up to 100. But populations have been in serious decline in recent years due to habitat loss, over-hunting

and poaching. This decline is a huge problem not only for the deer, but also for the tiger that depends on it as prey. Deer eats plant; tiger eats deer. But how much longer will this natural cycle last?

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit canon.com/environment to learn more.





December 2009

Worlds Apart

Good to know that scientists are searching for life out there. But I keep hearing of probes shot into space beeping our coordinates in hopes that some other life-form will discover us. Assuming that some of those life-forms have more advanced technology than we do (and some less) and some of those life-forms are more benevolent than humans (and some more vicious), do we really want to be bleating into space, "We're here! We're here!"

MARGARET READ MACDONALD
Kirkland, Washington

Your artist's rendering of the Milky Way spiral brought a smile to my face, as it recalled a favorite poster from the 1970s that first brought the cosmos into perspective for me: a similar graphic with an arrow pointing to an insignificant branch of the spiral along with the notation, "You Are Here."

DAVE ARNOLD
West Branch, Iowa

The Other Tibet

Calling Xinjiang "the other Tibet" may appear to be accurate, but it is in fact misleading. Although China's

primary interest in Tibet and Xinjiang is the protection of national sovereignty, Xinjiang is different from Tibet in two ways. First, Xinjiang has resources that make it truly valuable for China. Second, it is caught in a political-religious quagmire that associates Uygur nationalism with Muslim terrorism and al Qaeda. Xinjiang is not another Tibet. Tibet is a more publicized and easier to understand Xinjiang.

FELIX DE ROSEN
Cambridge, Massachusetts

If the Uygur people cannot be neatly classified as religious extremists, then neither can the Han Chinese be classified as opportunists seeking to exploit the Uygurs' native land. The Han migrants were lured west by the promise of food and clothing. It is unfounded to accuse these laborers settling the north of Xinjiang of estranging Uygur culture for their own interests. On a separate note, it's ironic to see restricted economic opportunity in spacious and flourishing Xinjiang. Much of the space is impassable desert.

JOYCE YANG
Rockville, Maryland

Comparing Xinjiang's deadly ethnic violence to the Tiananmen Square massacre is misleading. Many of those killed in the Xinjiang violence were Han Chinese, yet we cannot hear their side of the story in your article. It is as if they never existed. And praising the Uygur thugs who killed innocent civilians as freedom fighters is laughable. The Uygurs may have their legitimate grievance against some policies of the Chinese government, just as

some people in the Middle East may resent U.S. foreign policy. But there is no difference between attacking people in a marketplace using "rusty swords" and flying an airplane into a tall building. They are both terrorist acts.

SHU WU
Overland Park, Kansas

The Uygurs had my empathy until I reached page 48 of your story. The picture of Uygur men with fighting dogs sickened me. Gandhi said that a nation's greatness is judged by the way it treats its animals. The Uygurs may be oppressed and marginalized, but that doesn't excuse their mistreatment of animals.

DEBRA J. WHITE
Tempe, Arizona

In the article, street cameras are said to "reinforce Chinese control." The fact is, many cities in China have this kind of camera. Just as cities in the United States have surveillance cameras. Do these reinforce U.S. control?

CHUNZENG WANG
Presque Isle, Maine

Corrections, Clarifications

December 2009:

Geography: Sign Language

The correct meaning of sign No. 6 is "No dogs allowed, even leashed."

Health: Fighting the Flu

The time line should have referred to the 1963 quarantine as the last federal confinement.

Monks of Mount Athos

Page 142: The animal in the photo is not a mule. It's a donkey.

Email ngsforum@ngm.com

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How can we squeeze more food from a RAINDROP?



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LETTERS

The Hadza

Not long after reading the article on the Hadza of Tanzania, I heard John Lennon's "Imagine" on the radio, and several similarities struck me. Lennon sings of a new world where there is no religion, no countries, no possessions, greed, or hunger, everyone sharing the world and living life in peace. The Hadza people have little religion and are unaware of the rest of the world, let alone separate countries. They have few possessions and don't worry about famine. Everyone shares the land, living in peace with other tribes. It makes one wonder if Lennon channeled his possible African ancestors while writing the song.

ANDREW SHARO
Wayne, Pennsylvania

My heart goes out to the Hadza. It is sad that people who are hurting no one have little choice of how to live because some more powerful people now want their land. How many humans alive today still know how to knap a stone tool or start a fire with a stick in 30 seconds? Western culture and resource use, which many now believe to be unsustainable, has been adopted by most of the world. Maybe it would be wise, just as a sort of insurance policy, to leave the Hadza alone. We may never need the kinds of skills the Hadza still possess in order to survive another 10,000 years. But what if we did?

GAIL STUMPF NSENTIP
Fort Bragg, California

The Hadza are our past, and we are, on a technological time line, the latest advanced human society. During our travel in time from there to here, I wonder when, if ever, our ancestors had the optimal balance of health, security, comfort, and the "Hadza effect." No doubt this effect is imprinted in all humans; it has just gotten buried in all of our schedules, time crunches, emails, etc. While modern societies have minimized what seemingly plagues the Hadza, your excellent article (and those

amazing Hadza faces) illuminates those things we gave up long ago.

DARRILL ANDRIES
Lake Elsinore, California

I could not help but notice the strange eyes of every one of the Hadza photographed. Is there some sort of photographic anomaly that could explain why all their eyes have a squarish white center with a black vertical slit instead of an ordinary round pupil? Please help me understand.

PENNY BIRGER
Medford, Oregon

That "squarish white center" that you observed in the portrait subjects' eyes is actually the reflection of photographer Martin Schoeller's bright lights.

The Hadza's unwillingness to assimilate into society proves that they're content. Their smiles say it all. On another note, if Tanzania wants to portray itself as a "future-oriented nation," the government should celebrate the diversity of its people and embrace the Hadza's self-sufficiency. The tribe leaves little carbon footprint, albeit unintentionally. Perhaps Tanzania's government officials need to take a course in marketing.

RHONDA BETZ
Bloomington, Indiana

Resurrection Island

Here's one more South Georgia paradox. Author Kenneth Brower's stirring description of the abundance, vulnerability,

and resilience of life on South Georgia did not mention the role of our global obsession with petroleum. The human desire to protect the majestic baleen whales from extinction helped end industrial whaling, yet the availability of petroleum-based substitutes for whale oil also facilitated the preservation of cetacean populations. Now the cumulative effects of our consumption of petroleum and other fossil fuels are altering the environment in ways that jeopardize life at the base of the Antarctic Ocean's food chain. Thus humans may once again be endangering the marine mammal and bird populations of South Georgia.

DON BARBER
Bryn Mawr, Pennsylvania

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Get the Drift The element of water—whether in rivers, lakes, oceans, or swimming pools—and the element of surprise combine to create refreshing Your Shot images. To see what other readers have seen, take a look at the next few pages. For information on how to send us *your* best shot, go to ngm.com/yourshot. —Jeremy Berlin



EDITORS' CHOICE

Sarah Comerford Kinvarra, Ireland
Visiting Ireland's Fanore Beach, Comerford, 28, and a friend found a curious little raft made of wine corks, elastic bands, and lollipop sticks. They affixed a feather, "then set sail to it in the river that runs down the hills and onto the beach."

Melinda Dick Nanoose Bay, British Columbia
A former deputy sheriff who volunteers at a Vancouver Island bird center, Dick, 43, says, "Birds of prey are my passion." One hot day a resident male bald eagle named Manwe "decided it was bath time"—and quickly cooled off in a plastic pool.



READERS' CHOICE

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My Life:

A RENAISSANCE MAN IN PROGRESS!

My Lenses:

PHOTOCHROMIC AND HIGH INDEX.

My Lens Options:

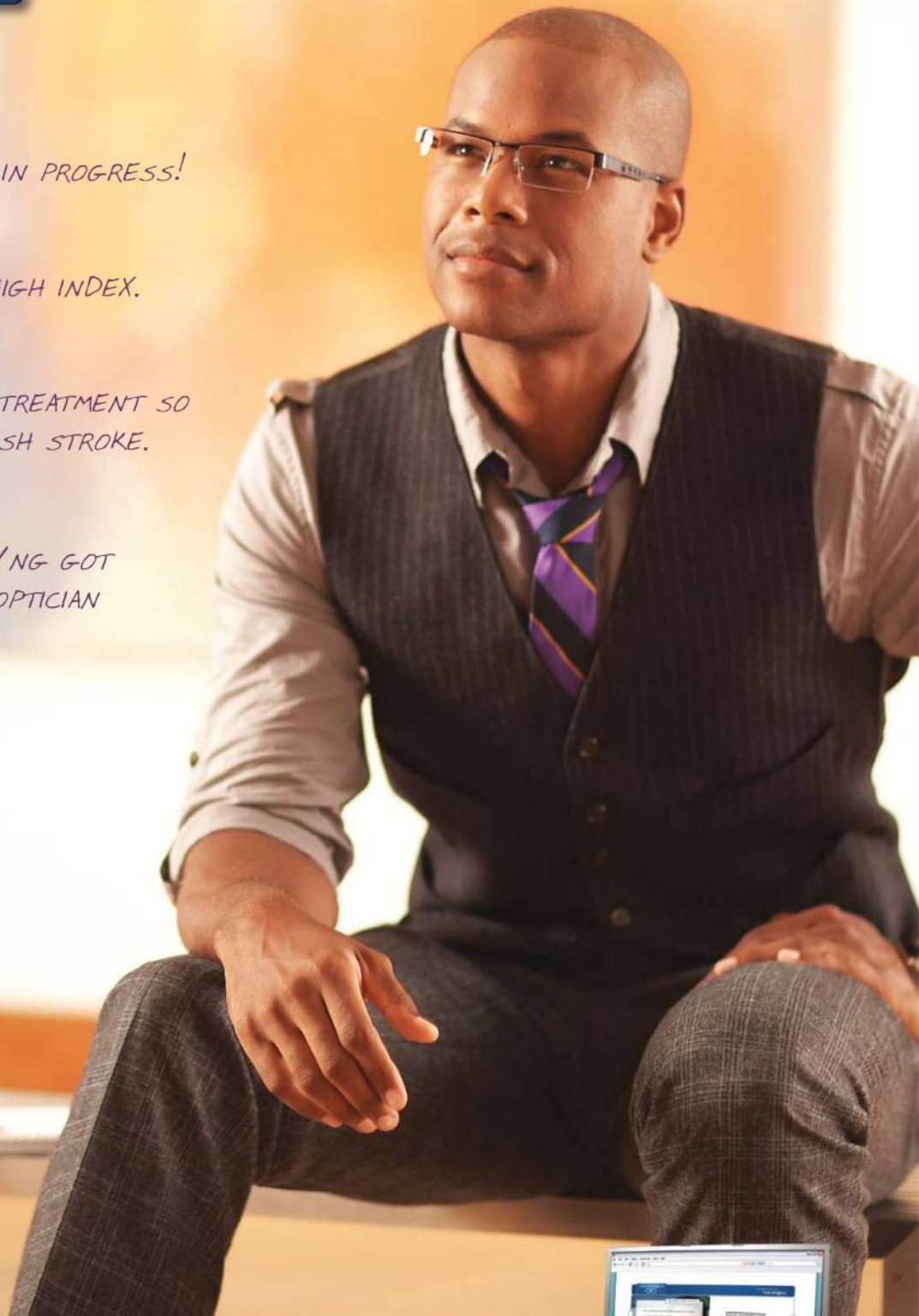
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Photochromic performance is influenced by temperature, UV exposure, and lens material.

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Tessa Pinczes

Sandringham, Australia

While vacationing last year in Fiji, ten-year-old Tessa Pinczes took this effervescent shot of herself in a hotel pool. “Interestingly,” adds her mother, Fiona, “the bubbles look just like the amazing irregular pearls” found on the Pacific island nation.



Rochelle Coffey

Lethbridge, Alberta

Freed by heavy rains falling on Ruby Ridge, argillite sediment makes Canada’s Cameron Falls run tomato-soup red. Coffey, 50, and her husband took this picture last year while camping in Waterton Lakes National Park. The next day, they say, the creek was clear.

Men who will become
vice presidents this year:

13,442

Who will retire
before age 60:

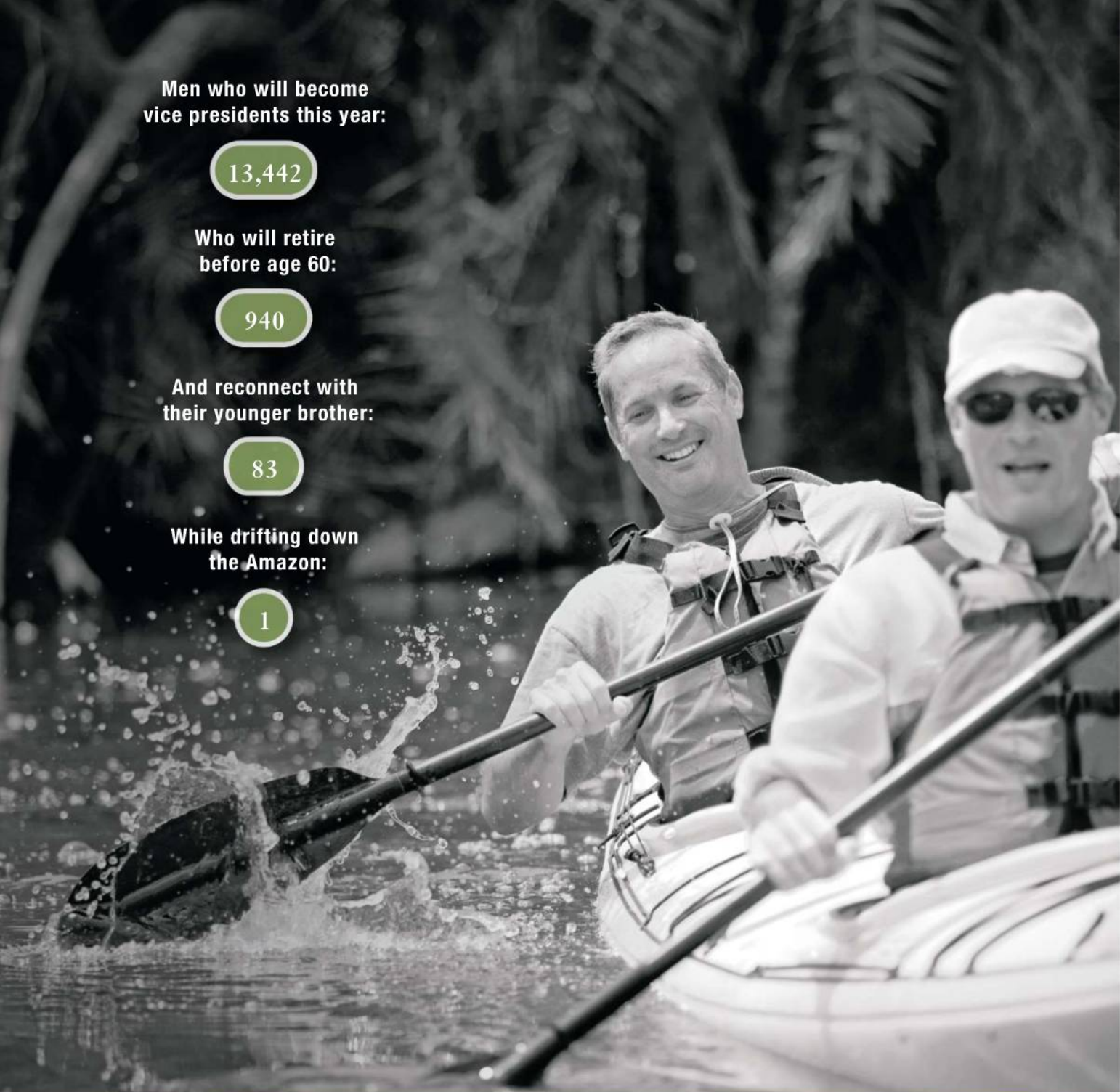
940

And reconnect with
their younger brother:

83

While drifting down
the Amazon:

1



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Omer Bublil
Yavne, Israel

After three years of military service, Bublil, 26, backpacked around the world. One highlight, he says, was the sight of these “lovely people jumping into the water” near Leshan, China.

Stephane Biscolli
Lexington, Kentucky

Biscolli, 36, was hiking in Florida’s Everglades when he spied this American alligator. Standing atop a small wooden bridge on the Anhinga Trail, he used a polarizing filter to reveal the reptile’s submerged body.

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Gavin Marchio
Sydney, Australia

Thousands of tons of dense dust made news when it blanketed parts of Australia last fall. To “capture the amazing scene,” the 45-year-old Marchio set up his camera and tripod beneath the Sydney Harbour Bridge at the break of a deep-red dawn.



Ethan Daniels
Berkeley, California

Relaxing between dives off Palau’s Ulong Island, Daniels, 37, saw a germinating coconut bobbing in clear, shallow water along an empty beach. The sight made him reach for his camera—and reminded him of the many ways different species can take root in a new land.

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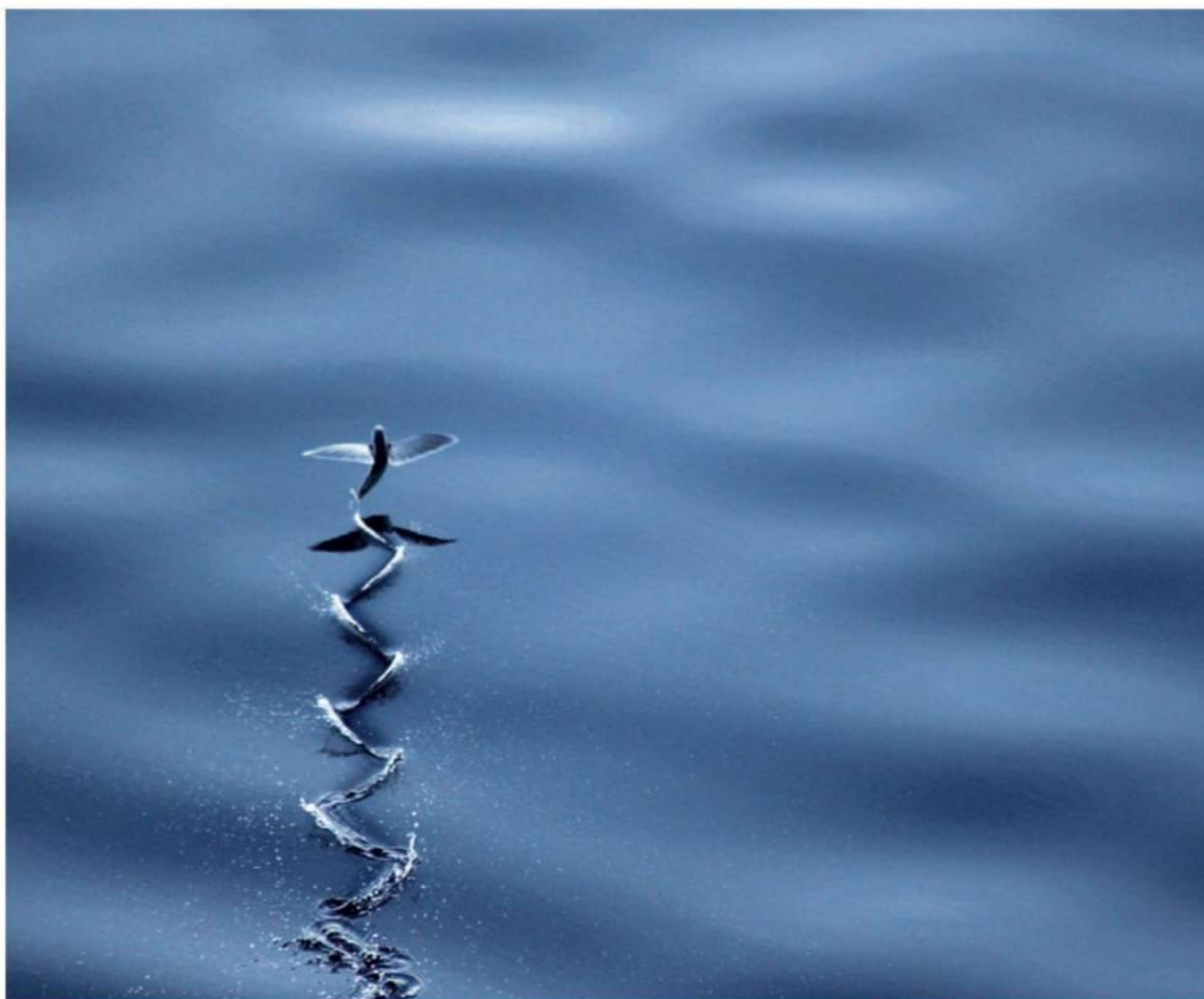


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Luther Bailey

Henderson, Nevada

When Bailey, 38, was sailing to Australia via the Timor Sea, “the water was so still that it was like looking in a mirror.” That calm helped him capture this flying fish’s zigzag pattern.

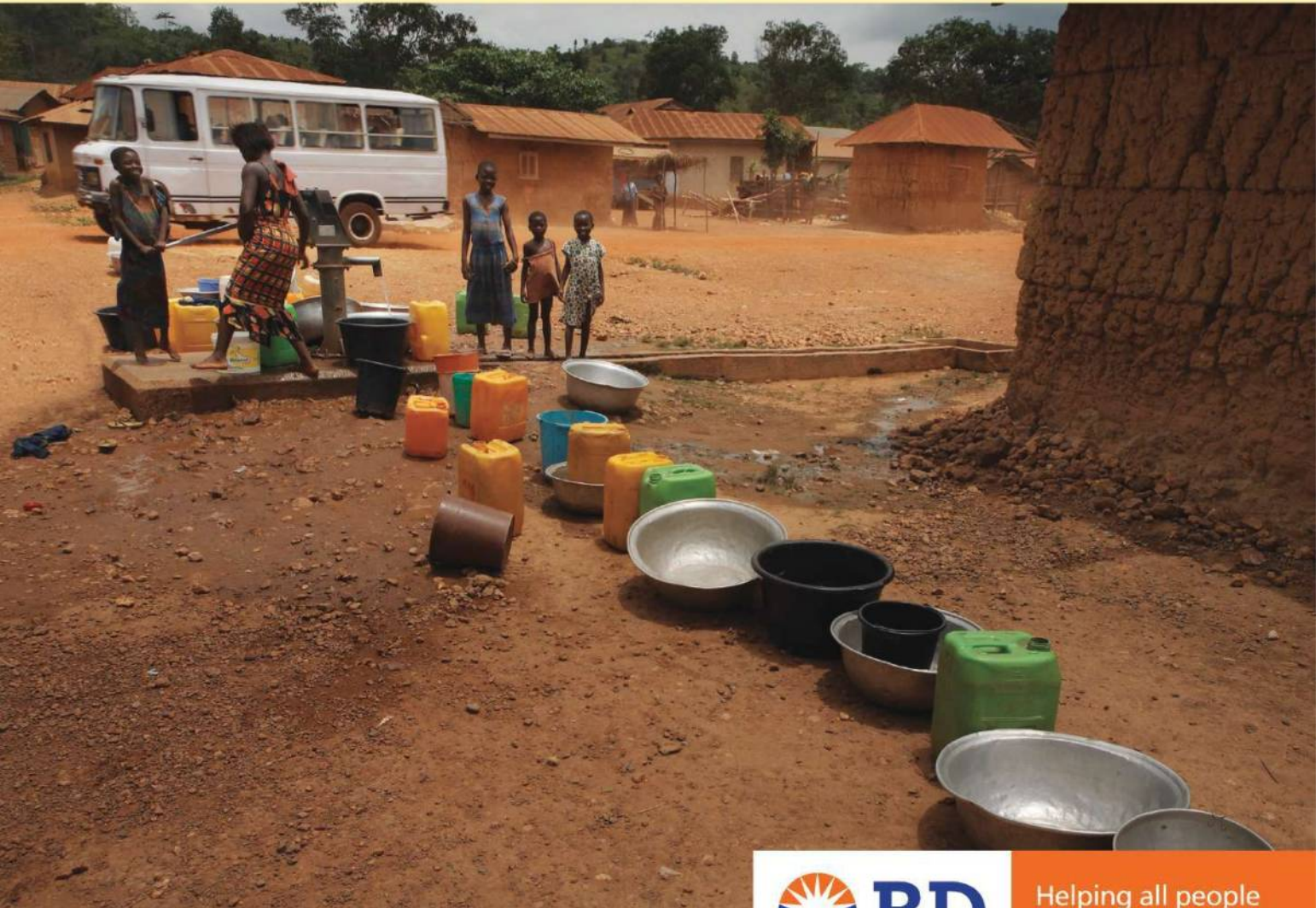
Norman Hyett

Cheltenham, England

Feeding his horses on a cold Christmas morning, Hyett, 63, noticed that the overnight wind and fog had made “strange and amazingly symmetrical ice formations” on the farm’s wire-netting fence.

Since 1948, Direct Relief International has helped people in need. In 2009, the organization provided more than \$148 million in material assistance to 60 countries.

Working to improve healthcare facilities in Ghana since 1991, Direct Relief has supplied more than \$5.5 million worth of medicine, medical supplies and equipment. For more information, please visit www.directrelief.org



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 live healthy lives

In Ghana, diseases like malaria, guinea worm and HIV/AIDS greatly challenge the country's healthcare system. A lack of medical resources limits patient care and undermines efforts in preventive medicine, particularly in rural areas.

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¹ FORTUNE, March 2009, ²Ethisphere™ Magazine, April 2009

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Jim Richardson, Kansas

Find rainy photographs (and more) in *The Complete National Geographic* DVD-ROM set. Go to completenatgeo.com for more information.

The Rain Catchers The storm that swept through the tallgrass prairie lasted two minutes and 30 seconds, just long enough for Jim Richardson to capture the slanting rain that pummeled the green slopes of the Kansas Flint Hills. To reach his vantage point, Richardson raced the thunderstorm for 70 miles. “The storm came through like a freight train and just as fast,” he recalls. “I had to shoot from the window of my car. There is no way you can be out in weather like that and keep the lens dry.”

Three or four minutes later, the clouds had moved on. Light reclaimed the horizon. A rainbow appeared and atoned for the storm, now spent.

Rain transforms. It softens a landscape and smudges the sky with its monochromatic palette. It leaves loveliness in its wake—the reflective veneer of rain slick on a street, a tremulous drop of water on a leaf, the constellation of aqueous diamonds on a spiderweb.

“Photographers love rain and would rather not have full sun,” Richardson says. “It’s the difference between a Russian novel and a Hallmark greeting card.” He remembers rain rolling through a loch in the Scottish Highlands, a sudden shower in Cusco on New Year’s Eve that chased celebrants and their champagne to the shelter of a veranda, and an unremitting Cornwall downpour, enjoyed indoors by the warmth of a coal fire. On the following pages, other *Geographic* photographers share their own watershed moments when rain fell and magic happened. —Cathy Newman

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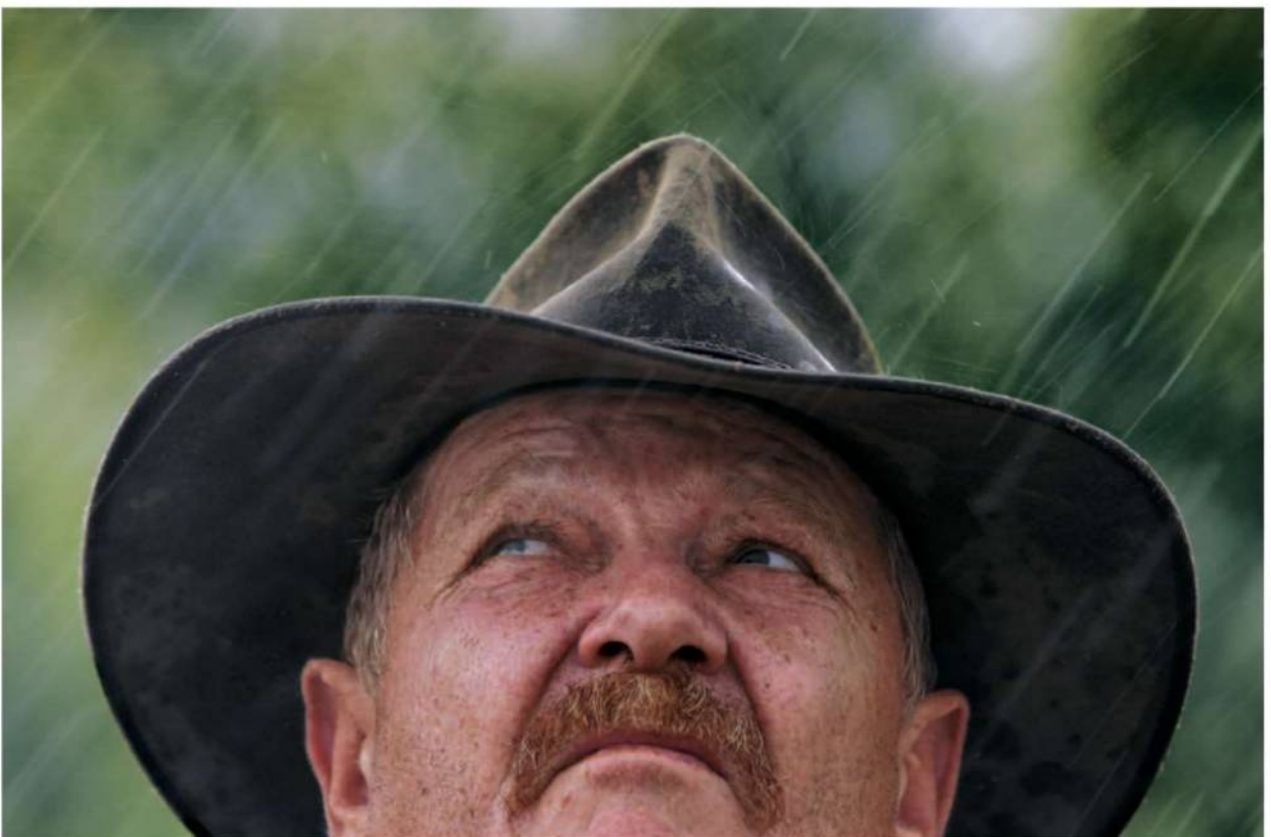
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Pascal Maitre, Chad A sudden storm drenches women near Abéché during the rainy season.



Randy Olson, Australia Long-awaited monsoon rains are an answered prayer for cattleman John Gostelow.

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But we come
a close second.

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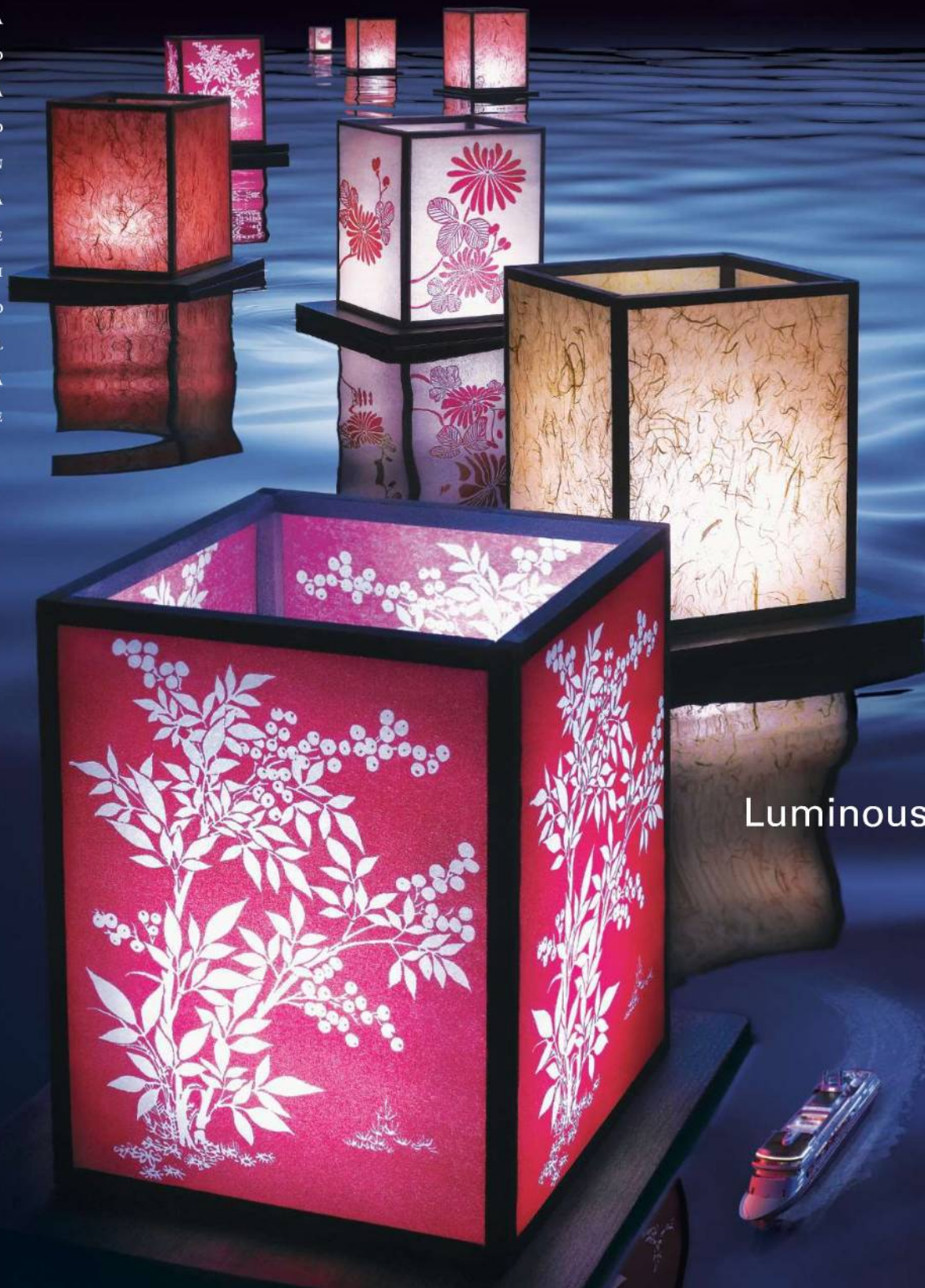


Jodi Cobb, New York City A scrim of rain and steam adds theatrical drama to Broadway's Times Square area.



Sam Abell, Japan An autumnal downpour dimples the surface of a private garden's pond in Hagi.

AFRICA
ALASKA
ASIA & PACIFIC
AUSTRALIA
NEW ZEALAND
CANADA
NEW ENGLAND
CARIBBEAN
BERMUDA
EUROPE
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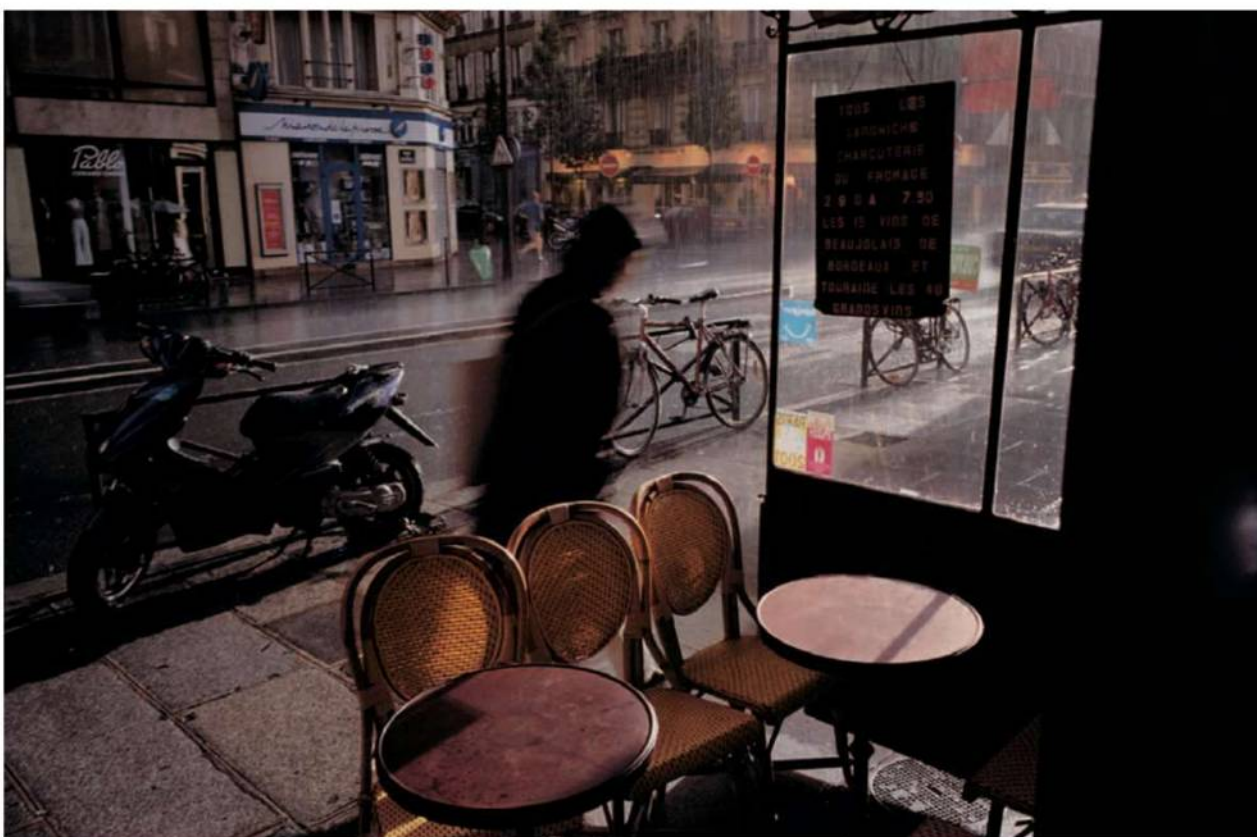
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Alex Webb, Brazil Panará Indian children in the Amazonian village of Nãnsêpotiti race the rain.



William Albert Allard, Paris A sun-shower washes the Rue de Rivoli in light the color of pale champagne.

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Imagine being pain free...

Imagine being filled with energy...



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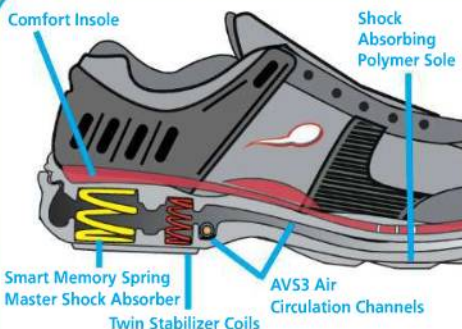
You will notice immediate relief of common pain during exercise as the springs of G-Defy athletic shoes absorb most of the impact --instead of your body-- by easing the stress on your joints, back and neck while walking, running, or jumping.



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Laos A boy swings over a turquoise pool at Kuang Si, a cascade-fed, sun-dappled sanctum 20 miles from the city of Louangphrabang. Located in a park near a wildlife-rescue center, the falls are famed for their limestone formations.

PHOTO: JOHN STANMEYER



India Parched people mob a vast well in the village of Natwargadh, Gujarat. In this drought-prone western state, yearly monsoon rains can total less than eight inches, and summer temperatures have topped 115°F.





Australia Brown with sediment loosed by seasonal rains, the King River snakes through coastal mudflats of the Kimberley, a remote northwestern region. In the dry months of May to September, the 76-mile meander is bare.



PHOTO: THEO ALLOFS, CORBIS



United States In 2007 high levels of bromate—a carcinogen formed when bromide and chlorine react with sunlight—were found in Los Angeles's Ivanhoe Reservoir. Today three million black plastic balls help deflect UV rays.



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PHOTO: GERD LUDWIG





Back to the Source

Where does your water come from? The faucet is only its final stop. Depending on where you are in the world, your supply may be drawn from groundwater, surface water such as lakes, rivers, and reservoirs, or desalinated seawater. Getting the water to you can be difficult. Century-old pipes in many Western cities mean that more than 10 percent of water is often lost to leakage. But in developing nations, better ways of delivering water seem to be on the rise. According to a 2008 WHO-UNICEF report, “improved water sources”—meaning those protected from some forms of contamination by pipes and other methods—now serve some 87 percent of the planet’s population, 1.6 billion more people than in 1990. —Margaret G. Zackowitz

Water sources

 Surface water
  Groundwater
  Desalination

Metropolitan population

More than 20 million

Tokyo

The Japanese city’s focus on same-day repair of leaky pipes is a big water saver. Its leakage rate is an impressively low 3.6 percent.



More than 10 million

Mexico City

In 2009 low reservoirs caused city government to ration water to five million residents. Water tariffs increased for city residents this year.



Dhaka

Demand for water far outstrips supply in Bangladesh’s capital, where groundwater levels are falling and paving impairs its replenishment.



Beijing

China’s capital depends on groundwater pumped from the northern province of Hebei. But Hebei’s underground reserves are running low.



Mumbai

India’s financial capital faced citywide water cutbacks in 2009 when levels in six nearby lakes and reservoirs used for storage fell low.



New York City

Three upstate reservoir systems hold some 580 billion gallons destined to flow—almost entirely by gravity, not pumping—to New York City.



Buenos Aires

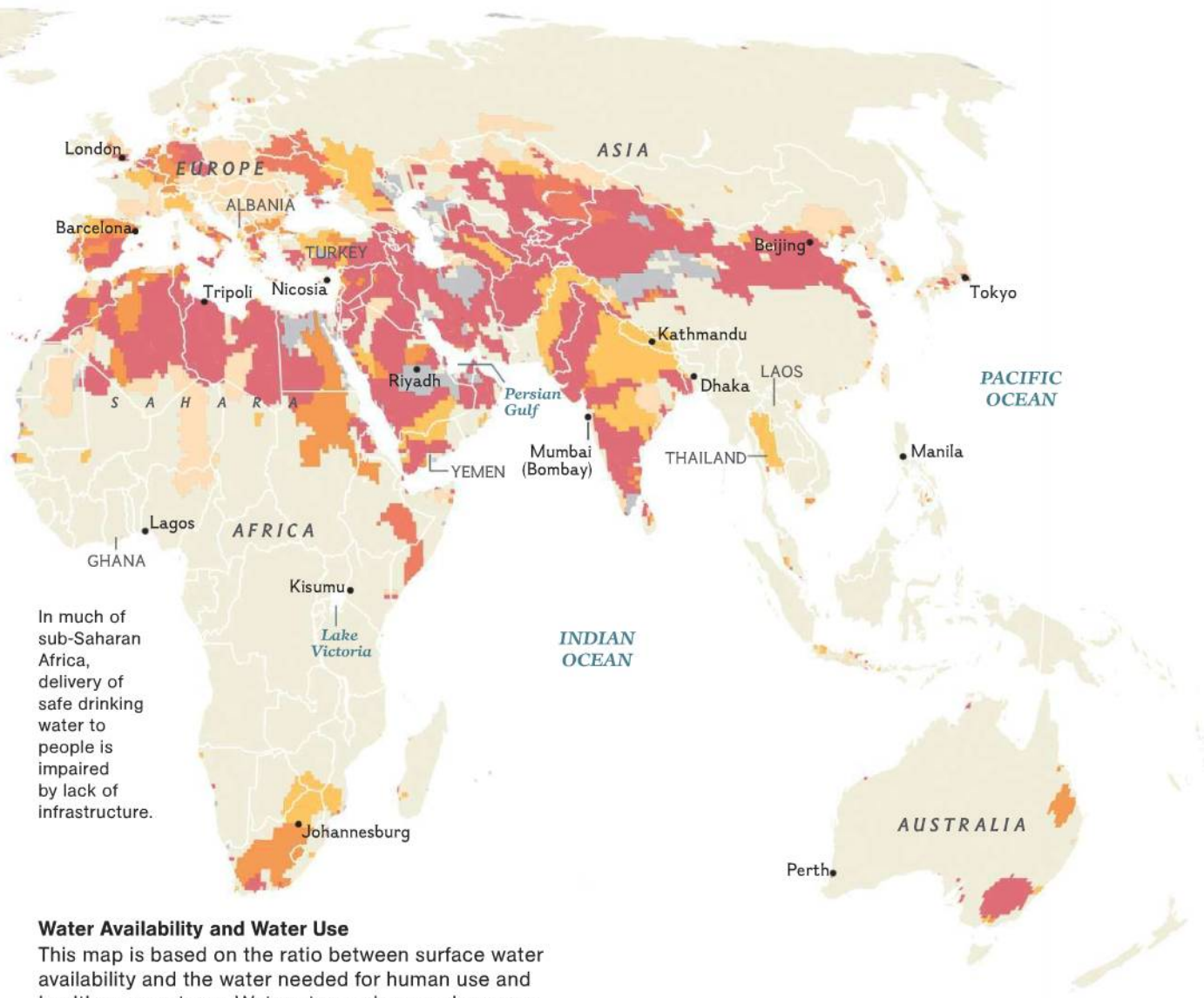
Argentina’s capital gets drinking water from the Río de la Plata. Rising groundwater levels have led to poor drainage, fouling local wells.



Manila

The Philippine capital uses water from the reservoir at Angat Dam—which sits on a major geologic fault and is vulnerable to earthquakes.





In much of sub-Saharan Africa, delivery of safe drinking water to people is impaired by lack of infrastructure.

Water Availability and Water Use

This map is based on the ratio between surface water availability and the water needed for human use and healthy ecosystems. Water-stressed areas shown are those where water use exceeds the natural renewable water supply and puts freshwater ecosystems at risk.

Less stressed ■ ■ ■ ■ More stressed ■ No data

More than 5 million

Lagos

Inadequate supplies of piped-in water in the Nigerian city lead many people in Lagos to dig their own wells or rely on local water sellers.



London

The Thames and other rivers supply more than 85 percent of London's water. Some 1,300 miles of Victorian water mains have recently been replaced.



Barcelona

Desalination plants are part of the plan for Spain's increasingly arid Catalonia region, where in 2008 drinking water was imported by tanker.



More than 1 million

Riyadh

Saudi Arabia's rapidly growing capital depends on desalinated seawater drawn from the Persian Gulf for most of its supply.



Lima

The capital of Peru gets little rainfall. It must rely on water from the Río Rimac and other rivers as well as a stressed groundwater supply.



Atlanta

In 2009 Georgia's state government battled with those of Alabama and Florida over use of its capital's main water supply, Lake Lanier.



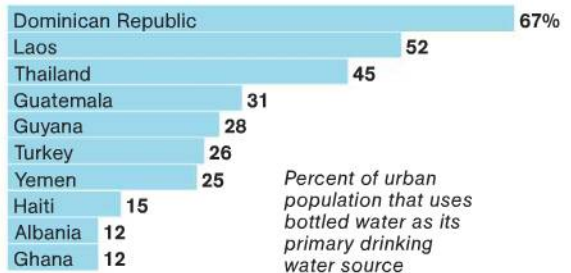


Yemenis travel to fill containers with drinking water in Sanaa.

REPACKAGED DEAL

Factory-bottled water or local tap water repackaged in bottles or plastic bags is the primary drinking water source for more than 10 percent of urban consumers in these ten countries.

BASED ON NATIONALLY REPRESENTATIVE HOUSEHOLD DATA, 2002-2005



Montreal

Montreal draws water from Canada's St. Lawrence River. Aging infrastructure causes about 40 percent to be lost to leakage before reaching consumers.



Tripoli

Libya's massive and ongoing Great Man-Made River project was begun in the 1980s to tap fossil aquifers beneath the Sahara.



Perth

The drought-stricken capital of Western Australia is beginning to rely on desalination plants to help add to its supply.



Fewer than 1 million

Kisumu

Kenyans get water—often polluted—from Lake Victoria or from seasonal lakes and streams. Many must walk for hours to get just a small daily supply.



Johannesburg

The South African city is one of the few big cities in the world not located near a major water source. Some of its supply is pumped from 30 miles away.



Las Vegas

The Colorado River supplies Nevada's Las Vegas Valley. Levels at Lake Mead, fed by the river, dropped by half in under ten years.



Kathmandu

Many residents must depend on groundwater drawn with private pumps in light of erratic municipal water service in Nepal's capital.



Nicosia

The divided city's water supply is also divided. It's administered by the Republic of Cyprus government and the Turkish Cypriot community.



NGM MAPS. PHOTO: AFP/GETTY IMAGES. GRAPHIC: MARIEL FURLONG, NGM STAFF
 SOURCES: GLOBAL WATER INTELLIGENCE; UNITED NATIONS POPULATION DIVISION; WHO AND UNICEF JOINT MONITORING PROGRAMME FOR WATER SUPPLY AND SANITATION; WORLD BANK WATER AND SANITATION PROGRAM; WORLD WATER COUNCIL
 MAP SOURCES: VLADIMIR SMAKHITIN; CARMEN REVENGA; PETRA DÖLL; INTERNATIONAL WATER MANAGEMENT INSTITUTE



BECOMING A POSITIVE WATER BALANCE COMPANY

We recognize water as a basic human right. It's also essential to our business. That's why our goal is to achieve positive water balance across all our businesses. For every liter of water we use, we intend to return one to the earth. Sound impossible? In 2009, we already did it across our PepsiCo India beverage operations. And India is just one step in our journey.



TO SAVE WATER, WE STARTED BATHING WITH AIR

Meanwhile in the US, we began cleaning new Gatorade bottles with purified air, instead of rinsing with water. It works so well that we're spreading this and other conservation techniques to bottling plants around the world, saving billions of liters of water from going down the drain.

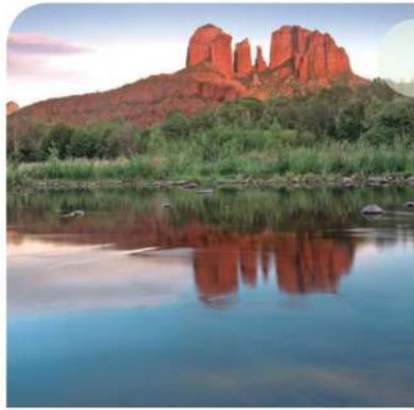
SOMETIMES THE SOLUTIONS JUST FALL OUT OF THE SKY

Instead of letting monsoon rains in India simply run off, we collect rain water from the roofs of our manufacturing plants and use it to rejuvenate surrounding aquifers. In other places, we create lakes and ponds to catch and store rain water.



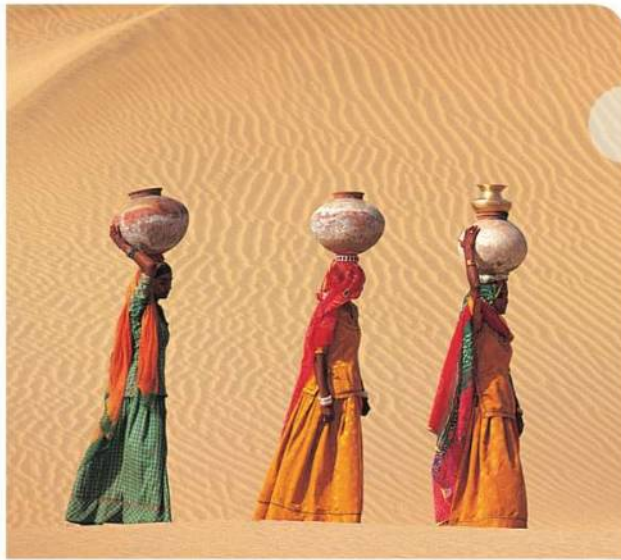
WE'RE WASHING POTATOES' OUTSIDES USING WATER FROM THEIR INSIDES

In the UK, our Walkers business has already reduced its water usage at their largest potato chip facility by a whopping 42%. Potatoes naturally contain a lot of water. We're now working to capture that moisture and use it to make our facilities there self-sufficient for water, basically unplugged from the water mains.



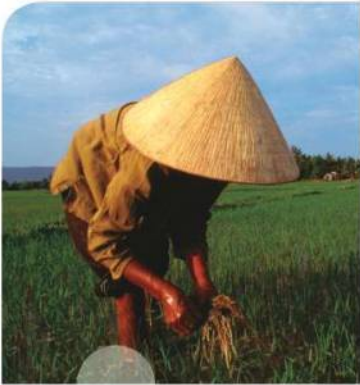
MAKING EVERY DROP COUNT...TWICE

We equipped our Frito-Lay facility in Arizona with a state-of-the-art water filtration and purification system to recycle and reuse approximately 80% of the process water used in production. For ten consecutive years, we've significantly reduced the amount of water used to make our Frito-Lay products in North America. And we have even bigger plans for the next ten years.



WATER TO THE PEOPLE, NOT THE OTHER WAY AROUND

No one should have to walk two hours for clean water. So we've partnered with non-governmental organizations (NGOs) to help install irrigation systems, improve sanitation programs and recharge dry wells in developing communities around the world. This year alone, we'll bring safe drinking water to over one million people in water-stressed regions such as China, India, Ghana and Brazil.



GROWING CROPS USING HALF THE WATER

Agriculture uses 70% of the world's water. That's why in China we're sharing conservation techniques with our local farmers. These efforts have cut the water usage required to grow potatoes for Lay's potato chips in China by more than half. And now, we're continuing to pioneer new methods to reduce agricultural water use in China and around the world by millions of liters.



THIS ISN'T JUST A DROP IN THE BUCKET

These are just a few of the ways we're reducing our global water footprint. So far, we've saved billions of liters. But water remains a scarce resource—both in quantity and quality. More than one billion people still lack access to clean water. So we're aiming to do more. It's good for people. It's good for the planet. It's good for business. It's time to walk the talk.



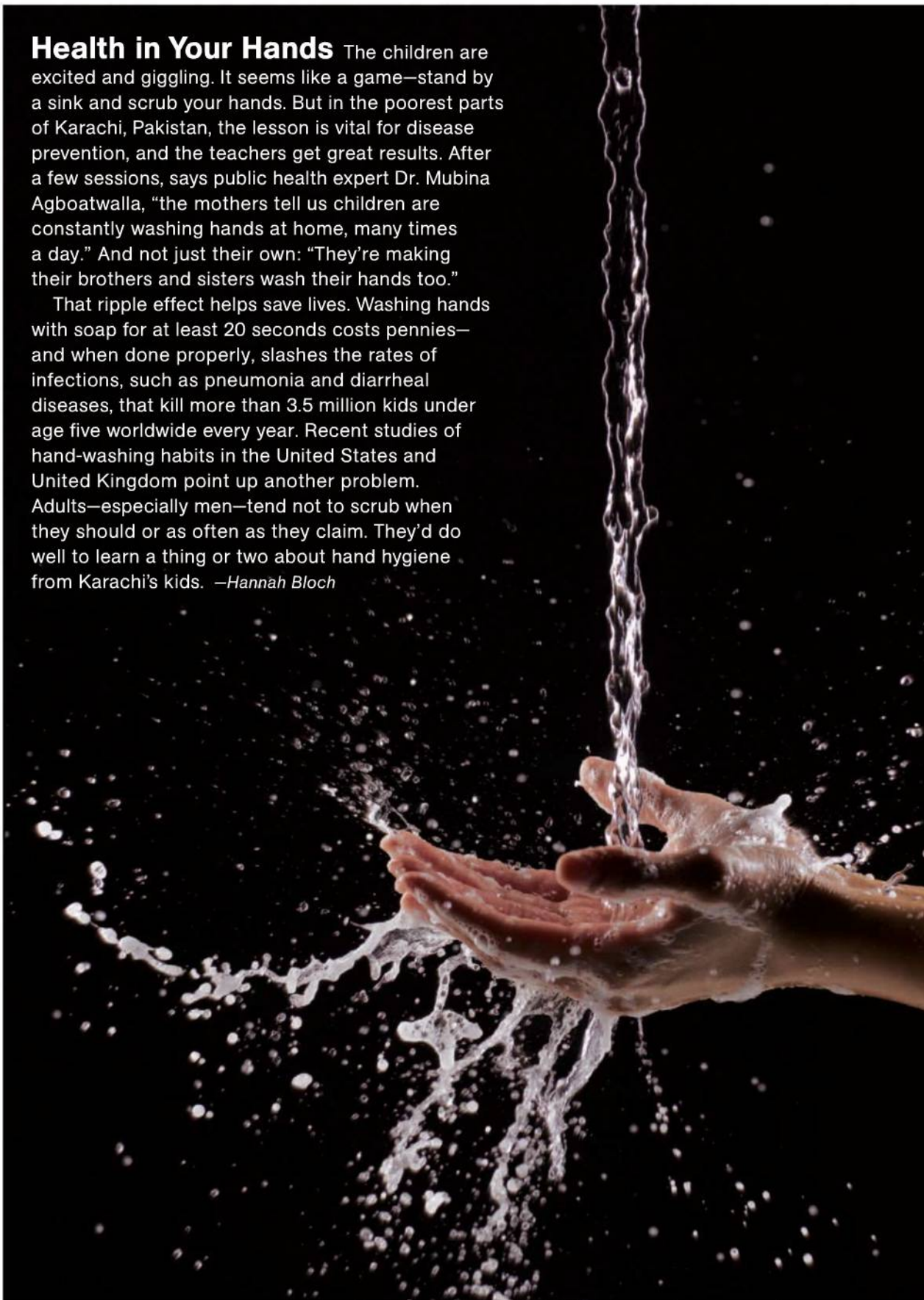
PEPSICO



pepsico.com/water

Health in Your Hands The children are excited and giggling. It seems like a game—stand by a sink and scrub your hands. But in the poorest parts of Karachi, Pakistan, the lesson is vital for disease prevention, and the teachers get great results. After a few sessions, says public health expert Dr. Mubina Agboatwalla, “the mothers tell us children are constantly washing hands at home, many times a day.” And not just their own: “They’re making their brothers and sisters wash their hands too.”

That ripple effect helps save lives. Washing hands with soap for at least 20 seconds costs pennies—and when done properly, slashes the rates of infections, such as pneumonia and diarrheal diseases, that kill more than 3.5 million kids under age five worldwide every year. Recent studies of hand-washing habits in the United States and United Kingdom point up another problem. Adults—especially men—tend not to scrub when they should or as often as they claim. They’d do well to learn a thing or two about hand hygiene from Karachi’s kids. —Hannah Bloch



Hand washing with soap is the most effective everyday way to limit the spread of disease.

PHOTO: MARK THIESSEN, NG STAFF

STOP UP TO 14 FEET SHORTER WITH A MICHELIN TIRE.



The MICHELIN® HydroEdge® Tire:

STOPPING DISTANCE	LONGEVITY	FUEL EFFICIENCY
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The MICHELIN® HydroEdge® Tire stops up to 14 feet shorter in wet conditions than a leading competitor¹! What's more, it lasts up to 33,000 miles longer than a leading competitor² and is the most fuel efficient tire in the category³. See how the right tire changes everything at michelinman.com/stopshorter.



1 – Based on third-party wet braking test results versus the Goodyear® Assurance® ComforTred® product line in wet testing. 2 – Based on third-party wear test results versus Goodyear® Assurance® products. 3 – Comparisons based upon fuel efficiency testing between MICHELIN® HydroEdge® tires, Goodyear® Assurance® TripleTred™ tires, Goodyear® Assurance® ComforTred® tires, and Bridgestone® Turanza® EL400 tires. Fuel savings are estimates based on comparative rolling resistance. Actual on-road savings may vary. Based on comparisons against the leading competitors in the standard S/T-rated all-season category. Copyright ©2010 Michelin North America, Inc. All rights reserved.

SPACE

WET WORLDS

Estimated potential volume of water and ice, relative to Earth's

- Ice only
- Ice and water

ORBITS NOT TO SCALE



Europa
2.9 Earths



Callisto
27 Earths



Earth's moon
.0000000002 Earths



Earth
366 million trillion gallons



Ceres
(dwarf planet)
.14 Earths



Mars
.003 Earths

Ice kicked up by a probe last fall confirmed frozen deposits in the moon's darkest regions.

JUPITER'S MOONS



Ganymede
36 Earths

The push and pull of tides within the ice may keep Europa, Ganymede, and Enceladus from fully freezing.

Water's Out There Earth isn't the only place in our solar system with water, as the ice found on the moon last year reminded us. Other planets' moons may be even wetter. Geysers that spray vapor on Saturn's satellite Enceladus hint at a liquid source near the cracked surface, while an ocean under the frozen shell of Jupiter's Europa could hold more than twice the water on our planet.

Water exists on Earth because our atmosphere keeps liquid from floating away or being disintegrated by solar radiation. Elsewhere it occurs mostly as ice, such as at the poles and middle latitudes of Mars and in shaded craters on Mercury. Yet in some places—like the liquid reservoirs on Saturn's moon Titan, which could be 15 times the size of Earth's seas—ammonia or other chemicals may lower the freezing point and sustain briny oceans.

So does any of this water benefit us? Scientists say space travelers might one day drink melted moon ice and convert it to oxygen or fuel for a trip to Mars. Meantime, the more we learn about how and where water survives, the more we understand Earth's most precious resource. —Brad Striber

SATURN'S MOONS



Titan
29 Earths



Enceladus
.02 Earths

Icy reservoirs likely exist on comets and bodies at the edge of the solar system.

GRAPHIC: OLIVER UBERTI, NG STAFF. ART: BRYAN CHRISTIE
SOURCES: M. A'HEARN, UNIVERSITY OF MARYLAND; B. BUTLER, NRAL; A. FORTES, UNIVERSITY COLLEGE LONDON; I. SHIKLOMANOV, STATE HYDROLOGICAL INSTITUTE, RUSSIA; T. SPOHN, DLR GERMANY; S. VANCE, JPL/CALTECH; T. WATTERS, SMITHSONIAN INSTITUTION

Conserving Resources



Protecting the Climate

Science For A Better Life

Climate change represents one of the major global challenges of our time. That's why Bayer is investing approximately \$1.5 billion between 2008 and 2010 in climate-related research and projects.

Through the Bayer Climate Program, the company is working to reduce its "climate footprint" and develop sustainable solutions. The Bayer Climate Check, for example, is a new tool for reducing CO₂ emissions in production processes.

With the aid of modern biotechnology, we are increasing the stress tolerance of crops against heat and drought, giving agriculture a chance to overcome the consequences of climate change.

To reduce energy consumption in offices and industrial buildings, we are working with partners to develop the "EcoCommercial Building." Based on highly efficient polyurethane insulation and regenerative energies, it can meet its own energy needs – a global concept for zero-emission buildings that can be implemented throughout the world. www.climate.bayer.com



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HealthCare

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MaterialScience

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TECHNOLOGY

Big Dipper Salt water from a southern ocean surrounds you. White sand lines the floor and shore. Sailboats dot the surface as snorkelers swim by. Welcome to...the world's largest pool.

Covering 20 acres and stretching half a mile, the swimming hole at Chile's San Alfonso del Mar resort is a 115-foot-deep, 66-million-gallon monster. (An Olympic-size pool is "only" 164 feet long, 6 feet 7 inches deep, 660,000 gallons.) Built for \$3.5 million by the Chilean firm Crystal Lagoons, which aims to open an even vaster version in the Egyptian desert, the pool has delighted resort guests and curiosity seekers since 2007. Now athletes are joining the list.

U.S. triathlete Amanda Stevens, 32, took a dip in—and a run around—the giant pool last year. "It stretches on forever and ever," she gushes. "There should be a training camp here!" —*Jeremy Berlin*



The world's largest pool is in Algarrobo, Chile, about 60 miles west of the capital, Santiago.



Pumped in from the Pacific, the water in this Chilean pool is 16°F warmer than the ocean.

PHOTO: ELISEO FERNANDEZ, REUTERS. NGM MAPS



THE LAWS OF GRAVITY DON'T APPLY TO EUPHORIA.

*My leash is broken. Nothing can keep me d
I can't find that kind of f
There's an e*



*... perfect for me,
... beaten path with everything
Page, Arizona ... makes this place and I a perfect fit
together. Nature can't be put on a leash, either.*

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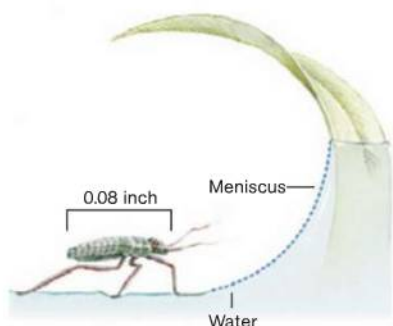
A water strider distorts the surface of a puddle with its legs.



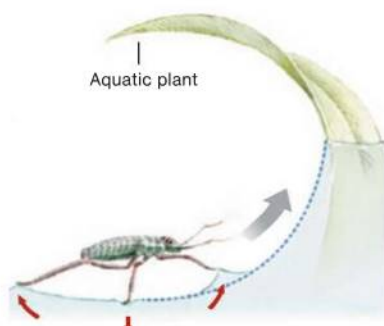
Up a Slippery Slope Gazing at a pond, you see a smooth surface. A tiny water-walking bug sees difficult terrain. Everywhere the water meets a leaf, a twig, or the shore, the surface curves up a fraction of an inch. The result is a meniscus, from the Greek word for “moon,” whose crescent shape is much like the water’s slope.

As you climb a hill, friction between your foot and the ground pushes you upward. But most water-walking insects skate on tiny pockets of air, making for a very slippery world. So how does such a bug scramble up a towering meniscus

to lay eggs on a leaf or escape a predator? MIT researchers John Bush and David Hu say it uses the same forces that clump breakfast cereal together in a bowl of milk. Watching high-speed videos, they saw that an insect approaching a meniscus reshapes the water surface below its body (graphics, below). Much as a trampoline gains energy when you stand on it, the surface of the water has more energy when a bug distorts it. Bugs use this energy to launch themselves up the meniscus—and away from the jaws of a hungry bass. —*Juli Berwald*



1 The bug walks to the meniscus—the curved water surface that forms because water is attracted to the plant.



2 To reshape the surface, water-grabbing claws on front and back legs pull up, and middle legs push down. The surface gains energy.



3 Energy from the reshaped surface pushes the bug up the meniscus. Grabbing the leaf, it pulls itself off the water.

Very high triglycerides
is a medical term for
something serious:

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Treat it with the only medication made
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If you have high cholesterol, high blood pressure, or diabetes, you may also have very high triglycerides, which is a serious medical condition. LOVAZA, along with diet, has been clinically proven to effectively lower very high triglycerides*, but it hasn't been shown to prevent heart attacks or strokes. LOVAZA is the only FDA-approved medication made from omega-3 fish oil. It's purified. It's concentrated. And you can't get it at a health food store. Ask your doctor about LOVAZA—the prescription that starts in the sea.

*Individual results may vary.

Important Safety Information for LOVAZA

LOVAZA, along with diet, helps to lower very high triglycerides (≥ 500 mg/dL) in adult patients. Tell your doctor if you are allergic to fish or shellfish as LOVAZA may not be right for you. Talk to your doctor about any medical conditions you have and any medications you are taking, especially those that may increase your risk of bleeding. In some patients, LDL-cholesterol levels may increase. Your healthcare provider should do blood tests before and during treatment with LOVAZA to check your cholesterol and triglyceride levels. If you have liver disease, you may require additional monitoring. Possible side effects include burping, infection, flu-like symptoms, upset stomach and change in sense of taste.

How supplied: 1-gram capsule

Please see important Patient Information on the next page.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

Ask your doctor if LOVAZA is right for you
Visit **LOVAZA.com** or call **1-877-LOVAZA1**


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Capsule shown not actual size

PATIENT INFORMATION

LOVAZA® (lō-vā-zā)
(omega-3-acid ethyl esters) Capsules

LOVAZA®
omega-3-acid ethyl esters

Read the Patient Information that comes with LOVAZA before you start taking it, and each time you get a refill. There may be new information. This leaflet does not take the place of talking with your doctor about your condition or treatment.

What is LOVAZA?

LOVAZA is a prescription medicine, called a lipid-regulating medicine, for adults. LOVAZA is made of omega-3 fatty acids from oils of fish, such as salmon and mackerel. Omega-3 fatty acids are substances that your body needs but cannot produce itself.

LOVAZA is used along with a low-fat and low-cholesterol diet to lower very high triglycerides (fats) in your blood. Before taking LOVAZA, talk to your healthcare provider about how you can lower high blood fats by:

- losing weight, if you are overweight
- increasing physical exercise

Treatment with LOVAZA has not been shown to prevent heart attacks or strokes.

LOVAZA has not been studied in children under the age of 18 years.

What should I tell my doctor before taking LOVAZA?

Tell your doctor about all of your medical conditions and all the medicines you take, including prescription and non-prescription medicine, vitamins, and herbal supplements. LOVAZA and certain other medicines can interact causing serious side effects.

Especially tell your doctor if you take medicines:

- To reduce clotting—known as anticoagulants or blood thinners. These include aspirin, warfarin, coumarin and clopidogrel (PLAVIX®).

Tell your doctor if you are allergic to fish and/or shellfish.

LOVAZA may not be right for you.

Who should NOT take LOVAZA?

Do not take LOVAZA if you:

- are allergic to LOVAZA or any of its ingredients.

What are the possible side effects of LOVAZA?

The most common side effects with LOVAZA are burping, infection, flu symptoms, upset stomach and change in sense of taste.

LOVAZA may affect certain blood tests.

It may change:

- One of the tests to check liver function (ALT)
- One of the tests to measure cholesterol levels (LDL-C)

Talk to your doctor if you have side effects that bother you or that will not go away.

These are not all the side effects with LOVAZA.

Ask your doctor or pharmacist for a complete list.

LOVAZA is a registered trademark of the GlaxoSmithKline group of companies.

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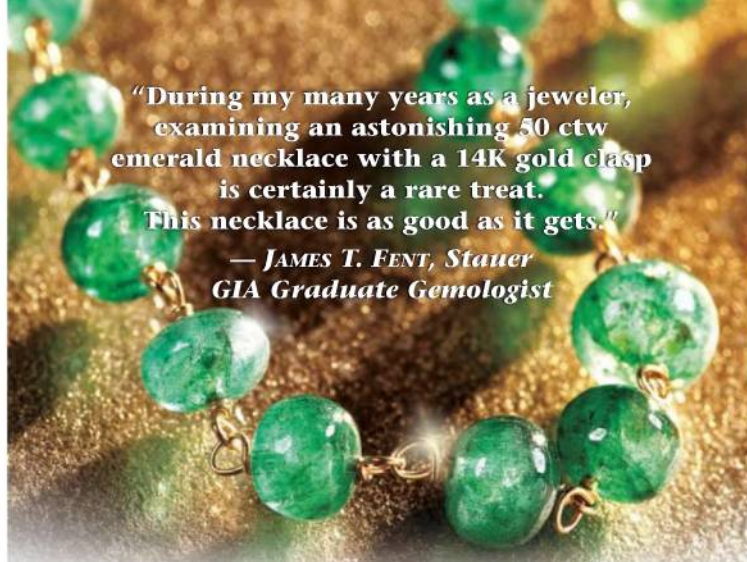


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Research Triangle Park, NC 27709

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December 2009



“During my many years as a jeweler, examining an astonishing 50 ctw emerald necklace with a 14K gold clasp is certainly a rare treat.

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*— JAMES T. FENT, Stauer
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It happened on our last trip to South America. After visiting the “Lost City” of Machu Picchu in Peru, we ventured through the mountains and down the Amazon into Brazil. In an old village we met a merchant with an impressive collection of spectacular, iridescent emeralds. Each gem was tumbled smooth and glistened like a perfect rain forest dew drop. But the price was so unbelievable, I was sure our interpreter had made a mistake.

But there was no mistake. After returning home, I had 50 carats of those exquisite emeralds strung up with a stunning 14k gold clasp. And I wrapped it as a gift for my wife’s birthday. That’s when my trouble began. She loved it. Absolutely adored it. *So what’s the problem?* I’m never going to find an emerald deal this good again. In giving her such a perfect gift, I’ve made it impossible to top myself.

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It's not the advice you'd expect. Learning a new language seems formidable, as we recall from years of combat with grammar and translations in school. Yet infants begin at birth. They communicate at eighteen months and speak the language fluently before they go to school. And they never battle translations or grammar explanations along the way.

Born into a veritable language jamboree, children figure out language purely from the sounds, objects and interactions around them.

Their senses fire up neural circuits that send the stimuli to different language areas in the brain. Meanings fuse to words. Words string into structures. And language erupts.

Three characteristics of the child's language-learning process are crucial for success:

First, and most importantly, a child's natural language-learning ability emerges only in a speech-soaked, immersion environment free of translations and explanations of grammar.

Second, a child's language learning is dramatically accelerated by constant feedback from family and friends. Positive correction and persistent reinforcement nurture the child's language and language skills into full communicative expression.

Third, children learn through play, whether it's the arm-waving balancing act that announces their first step or the spluttering preamble to their first words. All the conversational chatter skittering through young children's play with parents and playmates—"...what's this..." "...clap, clap your hands..." "...my ball..."—helps children develop language skills that connect them to the world.

Adults possess this same powerful language-learning ability that orchestrated our language success as children. Sadly, our clashes with vocabulary drills and grammar explanations force us to conclude it's hopeless. We simply don't have "the language learning gene."

At Rosetta Stone,[®] we know otherwise. You can recover your native language-learning ability as an adult by prompting your brain to learn language the way it's wired to learn language: by complete immersion. Our award-winning, computer-based method does just that.

What's the fastest way to learn a language?

ACT LIKE A BABY.

Dynamic Immersion[®] unlocks the innate language-learning ability you acquired before birth and mastered as a child.

By recreating the immersion context in which you learned your first language, you understand, speak, read and write your new language with confidence and accuracy from the beginning—without translations and explanations.

At every step and in every skill, you receive instant, actionable feedback, including speech recognition and analysis technologies that prepare you for everyday conversations. And Adaptive Recall[®] brings back material just when you need it to reinforce and perfect your learning.

Every act of learning is an act of play for children and there's no reason it

should be different for learners of any age. With Rosetta Stone programs, you rediscover the joy of learning language. Clever, puzzle-like activities produce sudden "Aha!" moments and astonishing language discoveries.

Your "language brain" remembers. We see it all the time.

A slow smile sneaks across the learner's face after just a few screens. It's a smile of recognition, as though the brain suddenly recalls what it was like to learn language as a child, as though it realizes, "Aha! I've done this before."

Act like a baby? You bet. Visit our website and find out how you can reactivate your own innate, language-learning ability with Rosetta Stone. It's the fastest way to learn a language. Guaranteed.[®]

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Water is disinfected using the sun's energy in the Kibera slum of Nairobi, Kenya.

High Marks for Clean Water Retrieve a discarded water bottle. Tear off the label and fill with any water that's not too murky from a creek, standpipe, or puddle. Place the bottle on a piece of metal in full sun. In six hours the UVA radiation will kill viruses, bacteria, and parasites in the water, making it safe to drink.

SODIS, the acronym for this Swiss-pioneered water-disinfection program, is now being used all over the world to provide drinking water for some four million people. "It's simple, it's free, and it's effective," says Ibelatha Mhelela, principal of the Ndolela Primary School in Tanzania. In 2006 her school started using SODIS to disinfect its contaminated tap water, placing bottles on the building's corrugated metal roof. The result? Absenteeism due to diarrhea dropped considerably, and examination scores soared. "Before we started SODIS, only 10 to 15 percent of the children passed the national sixth-grade exams," says Mhelela. "Now 90 to 95 percent of the students pass." —Mark Jenkins

ALL BOTTLED UP

Continuous, strong sunlight does all the hard work of SODIS. But the following tips help the process along.

- 1 Use bottles of clear PET plastic rather than glass. Studies show water from sun-warmed PET is safe to drink.
- 2 Do not disturb bottles while they sit in the sun.
- 3 Store water in bottle to prevent recontamination.

PHOTO: SVEN TORFINN, PANOS



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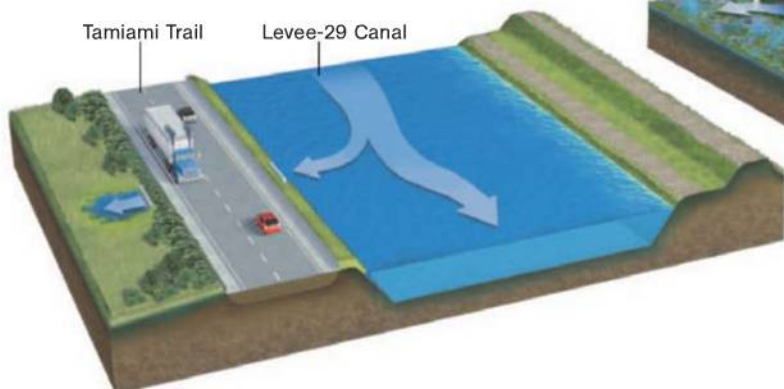
A Go for the Flow

Call it a reversal of misfortune for the fish, wading birds, and gators of Everglades National Park. Since the 264-mile Tamiami Trail was built in 1928, the stretch from Miami to Naples has choked off freshwater flow into the park, where it is essential for plant and animal survival. But late last year ground was broken on a one-mile bridge that will rise 20 feet above sea level. As part of the project, nearly ten miles of the road will be raised as well. These efforts should reestablish the flow running down from Lake Okeechobee and revive the saw grass that was wiped out by the trail. Completion is set for 2013.

The project actually dates back to 1989, when Congress approved an act to restore water delivery to the park. But various groups clashed over the next step. "It's taken 20 years to turn a bit of the spigot back on," says Tom Van Lent, senior scientist at the Everglades Foundation. More bridges will be built in the years ahead, and most of the canals and dams south of the lake will eventually be dismantled. "The idea," says Van Lent, "is to restore the Everglades as a 'river of grass.'" —Linda Kulman



PRESENT



FUTURE



Raising a one-mile stretch of road and lowering the bank of the canal should increase water flow to Everglades National Park marshland by 35 to 40 percent—about 70 million gallons a day.

NGM MAPS. MISR IMAGE: NASA/JPL. GRAPHICS: HIRAM HENRIQUEZ

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In Bellavista, Peru, fog clings to saplings and nets that generate thousands of gallons of water.

NG GRANTEE **Water From Air** There's a hillside village outside Lima, Peru, called Bellavista—even though the “beautiful view” is blocked in winter by dense fog that rolls in from the Pacific. But locals are putting all that moisture to good use. With the help of German conservationists Kai Tiedemann and Anne Lummerich, they're coaxing it out of the air, using multilayered nets to capture fog and condense its fine droplets into water—lots of it.



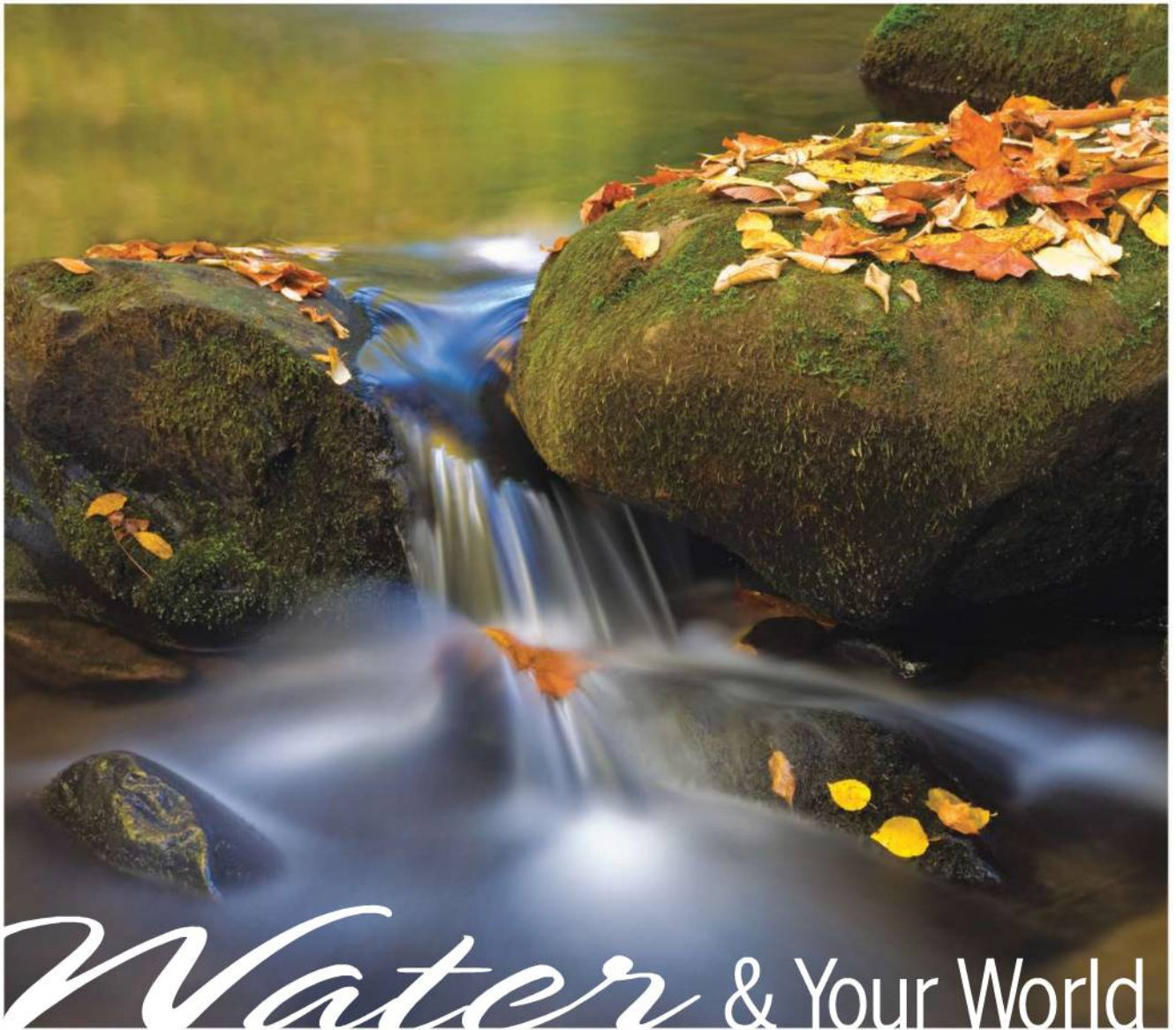
Just half an inch of rain falls here each year, so before the nets were set up on the hillcrest in 2006, villagers had to spend up to 15 percent of their earnings to truck water up from Lima.

Now the fog generates tens of thousands of gallons of water a year, with which residents can sustain 700 young trees and ten farm gardens year-round. As the trees grow, Tiedemann hopes they'll help naturally restore a formerly lush landscape. “These hills used to be covered in forests,” he says. “Once the trees were cut down, nothing was left to catch the fog.” In the meantime, today's 26-foot-long nets are designed to serve that purpose.

Globally, fog-catching projects have caught on in small communities from Ecuador to Eritrea when other options are too costly or unavailable. The downside? For now, says Lummerich, “we can produce a lot more water than we can store.” —*Hannah Bloch*

FOG-CATCHING STEPS


- 1 Tiny, windblown droplets of fog catch in layers of plastic mesh netting, then clump into larger drops that are funneled into pipes.
- 2 The water gushes into two tanks and an underground reservoir, which can store over 26,000 gallons total.
- 3 The water nourishes tree saplings whose mature branches and leaves will capture fog naturally.
- 4 Farther downhill, farm gardens also benefit from fog-water cultivation.



Water & Your World

"We forget that the water cycle and the life cycle are one."

JACQUES-YVES COUSTEAU

Rivers and lakes, our freshwater ecosystems, provide us with much more than clean drinking water. They water our crops, power our factories, light our homes, and transport people and goods in all parts of the globe. It's staggering to think that our freshwater sources—which comprise a minimal amount of Earth's water—can give us so much. Read on to learn about the vital connection between water and your world, and how a unique collaboration is creating solutions to help preserve and protect this fragile resource. 



What's even more staggering
than how little fresh water Earth has
is how much water
we as a people waste or spoil each day.



Experts warn that within the next 20 years, half of the world's population could face water shortages. Even here in the United States, where many believe clean, fresh water will always be a turn of the tap away, there could be serious shortages in the not-so-distant future.

While experts agree that we may be facing water shortages in the coming decades, they also argue that a major crisis can be averted. Practical solutions exist—ones that will allow us to meet our freshwater needs today while preserving nature's ability to meet those growing needs in the years ahead. We must strike a delicate balance for sustainability.



Global warming, deforestation, pollution, and other environmental pressures are shrinking the planet's clean water supply, making people look at fresh water as they never have before.

The people at *Crystal Light*, one of Kraft Foods' most popular brands, saw the connection—and an opportunity to help. “*Crystal Light* waters your body,” says Steve Yucknut, vice president of sustainability at Kraft Foods. “By launching a program that protects our water sources and encourages women to get involved with conservation at the community level, we’re helping to build awareness about the importance of clean freshwater sources in the U.S.”

Their solution: A collaboration that makes a world of sense—and underscores a dedication to shared goals. This year, *Crystal Light* has chosen to support The Nature Conservancy through a program devoted to preserving America's freshwater sources. The Conservancy, a leading conservation organization, draws on 50 years of on-the-ground experience, using its scientific expertise, business savvy, and unwavering commitment to collaboration in preserving nature's dwindling resources.

By giving funds to The Nature Conservancy, *Crystal Light* will help support several fresh-

water conservation projects that sustain life and livelihood along some of America's most celebrated bodies of water. Tools will be developed to help improve water management for the Potomac River, which is being impacted by water management structures from a variety of municipalities and the rapid population growth in Maryland, Virginia, West Virginia, and the District of Columbia. The Colorado

River, the lifeblood of the intermountain West, will undergo habitat restoration for native fish and plants. And landowners will be engaged to identify and initiate new on-the-ground conservation projects along the Meramec River, thereby improving conditions in this tributary of the

Mississippi River. These are just a few of the projects under way.

Rivers and lakes are essential to many industries, including fishing, manufacturing, and farming. They serve as vital channels of transportation. And, of course, they provide people with a healthy source of clean drinking water, essential for human existence.

*A Fresh
Solution Becomes
Crystal Clear*



*This year,
the World Water Day
celebration is
bigger than ever.*

In honor of this special day, *Crystal Light* is giving 100 percent of its net profits (no less than \$350,000, and up to \$750,000) from powdered drink mix products sold on World Water Day, March 22, 2010, to The Nature Conservancy. The proceeds will support several freshwater projects throughout the country.

"Water has always been at the heart of *Crystal Light*," says Yucknut. "And *Crystal Light* is doing its part to preserve America's freshwater sources."

To find out more and show your support, visit CrystalLight.com/WorldWaterDay.

Water & Your Health

When it comes to water and your health, the experts are unanimous: Water is the beverage of choice, naturally. Water is essential for human existence. It is also an essential nutrient for our bodies. Without it we would perish. The amount of fluids we need to consume every day varies from person to person depending upon how hot it is outside, our activity level, age, and health status. Generally speaking, drinking when thirsty and eating a balanced diet that includes fluids with meals is enough to satisfy fluid requirements. Women need about nine cups of fluids a day from water and other beverages; men about 13 cups. Here are some tips to help you stay adequately hydrated:

- Drink plenty of fluids when it's hot outside.
- When working out, be mindful of drinking fluids during and after your workout, especially if exercising in the hot weather or at high altitudes.
- Don't forget that the foods you eat add water to your diet too. Fruits such as watermelon, vegetables, soups, and gelatins are rich in water.
- Carry a small refillable bottle with you and drink during your commute, waiting in a store line, or watching your child's game.
- Juice can be high in calories. If you are watching your calories, try filling half the glass with water and the rest juice.
- Add flavor to your water with a squeeze of lemon or a powdered drink mix.



Crystal Light.

Golf's Hot Green

A humble turfgrass has won the golf trifecta, earning raves from duffers and greenkeepers as well as environmentalists.

Paspalum turf tolerates short droughts and thrives on brackish water, making it ideal for coastal courses. Easily maintained using low-quality water pumped locally, it saves freshwater supplies. The salt, meanwhile, kills weeds, reducing the need for chemicals. Over the past decade horticulturists have created strains that carpet tropical courses worldwide.

Paspalum isn't perfect: Pests that like turfgrasses remain a problem, and replanting an entire course with it is expensive. Still, its popularity continues to grow, especially among players. "The ball just sits up on its blades," says Miami pro Mark Zachary. "It doesn't get much better." —Peter Gwin



2 billion

Average number of gallons of water used each day for golf course irrigation in the U.S.

Paspalum turf resembles Bermuda grass in many ways—except that it can abide brackish water.

PHOTO: RICHARD PATTERSON. SOURCE: GOLF COURSE SUPERINTENDENTS ASSOCIATION OF AMERICA

Barreling Ahead Micah Parkin is defiant about the rain barrel she uses to collect water from her Boulder, Colorado, rooftop for her garden. “I’m conserving water,” she says, flouting a state law prohibiting most homeowners from storing roof runoff. “I’m also saving the energy it would take to purify that water in a treatment plant. The untreated water is better for the plants, anyway.”

Such logic has long been trumped by a 150-year-old system of “first in time, first in right” water laws.

The state protects farmers, ranchers, and others with existing rights to runoff that would normally flow into rivers and other drainages. With sustainability concerns on the rise, this may be changing. Last year Colorado passed a

law that allows homeowners without access to a municipal water tap to harvest rainwater. The new law also authorizes ten pilot programs to test the impact of collection. “If these can operate with little or no impact to senior water rights, maybe we can tweak things,” says Dick Wolfe, Colorado’s state engineer and de facto water police chief. But Parkin’s not about to ditch her barrel. “Collecting rainwater isn’t a crime,” she says. “Or at least it shouldn’t be.” —Alex Markels



RAIN ADDS UP

Rooftop rainfall is not just a drop in the bucket. This estimate is for a single home in Denver, Colorado.



= **16,575** gallons*
 or
65% of the annual water needs for a moderately landscaped yard



Ginger Janssen, who lives near Basalt, Colorado, benefits from a new law allowing rural rainwater collection.

*ASSUMES 15 PERCENT OF RAINFALL WILL BE LOST TO EVAPORATION OR ABSORPTION. PHOTO: PETE MCBRIDE. NGM MAPS



American Revolution Silver Dollars FOUND!

Authentic coins from 1783 – the year we won our independence!

A fishing expedition off the southern coast of the U.S. recently netted a cache of American silver dollars lost at the bottom of the sea for over 200 years—and upon closer examination it was discovered that many of these coins are dated 1783—the year we won our freedom!

The Silver Dollar of our Founding Fathers.

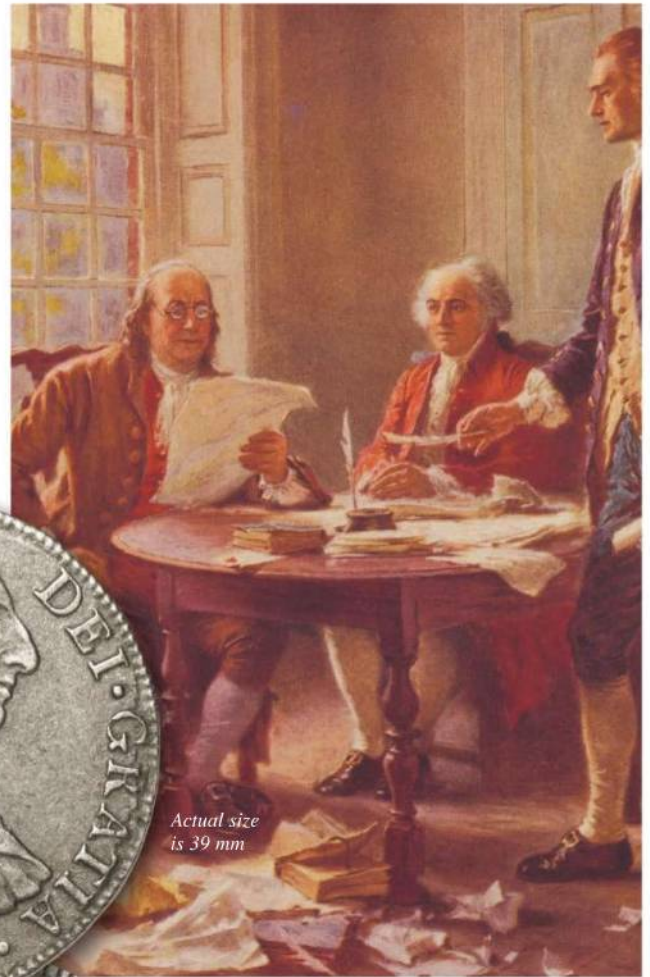
George Washington, Thomas Jefferson and Ben Franklin could have carried these same coins in their pockets at the time our country was born. Jefferson recommended the Continental Congress adopt this silver dollar as the country's FIRST silver dollar. Congress agreed. The rest is history. And now that they are available to the American public, the coin of our founding fathers is *tangible history you can secure for your very own.*

Now, through this discovery, you can own a set of TWO of these historic treasures — at a truly affordable price! Authentic items from the time of the Revolutionary War are seldom found or can be seen only in museums. Over the last 225 years most colonial American silver dollars have been lost or melted down for their precious silver.

Containing a hefty 27 grams of 90.3% silver these coins were real money back then—and real money today. They currently sell elsewhere for as high as \$295 each. But because of this historic discovery and our exclusive negotiations, for a limited time, you can own not just one of these coins of our Founding Fathers, but a set of TWO 1783 Silver Dollars—for our Guaranteed best price of only \$149! That's less than \$75 for each Silver Dollar! Both coins were hand selected for their detail, one featuring a visible date on its front, and the other the Spanish Coat of Arms on its reverse. And both are beautifully mounted in a special full color protective display. This is American history you



Actual size is 39 mm



and your family can own and give as gifts to your children and grandchildren—gifts they are certain to treasure and lovingly pass down for generations!

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97.5%

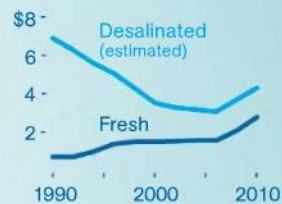
of the water on Earth is salty. Around one percent of that is brackish groundwater.

2.5%

of the Earth's water is fresh. About two-thirds of that is frozen; the rest is liquid surface water and groundwater.



Wholesale water cost in southern California
(per 1,000 gallons)



Better technology has driven desalination costs down—closer to the price of fresh water—though lately they've risen again with energy and materials prices.

16 billion

gallons are produced daily by the world's 14,450 desalination plants. Persian Gulf countries rely mostly on seawater.

There's no shortage of water on the blue planet—just a shortage of fresh water. New technologies may offer better ways to...

Get the Salt Out

THREE HUNDRED MILLION PEOPLE now get their water from the sea or from brackish groundwater that is too salty to drink. That's double the number a decade ago. Desalination took off in the 1970s in the Middle East and has since spread to 150 countries. Within the next six years new desalination plants may add as much as 13 billion gallons a day to the global water supply, the equivalent of another Colorado River. The reason for the boom is simple: As populations grow and agriculture and industry expand, fresh water—especially clean fresh water—is getting scarcer. "The thing about water is, you gotta have it," says Tom Pankratz, editor of the *Water Desalination Report*, a trade publication. "Desalination is not a cheap way to get water, but sometimes it's the only way there is."

And it's much cheaper than it was two decades ago. The first desalination method—and still the most common, especially in oil-rich countries along the Persian Gulf—was brute-force distillation: Heat seawater until it turns to steam, leaving its salt behind, then condense it. The current state of the art, used, for example, at plants that opened recently in Tampa Bay, Florida, (*Continued on next page*)

ART BY BRYAN CHRISTIE
SOURCES: TOM PANKRATZ,
GLOBAL WATER INTELLIGENCE;
INTERNATIONAL DESALINATION
ASSOCIATION; MARK A. SHAN-
NON, UNIVERSITY OF ILLINOIS;
ALEKSANDR NOY, UNIVERSITY
OF CALIFORNIA, MERCED

"As the master craftsman who opened the famous Lincoln Pocket Watch at the Smithsonian, I recently reviewed the the Stauer Meisterzeit timepiece. The assembly and the precision of the mechanical movement ranks with the best."

—George Thomas
Towson Watch Company



We Can Only Find One

A rare chance to claim a unique piece of watchmaking history for under \$100!

Eighty-six years ago, a watchmaker in Paris famous for building the magnificent clocks at Versailles created a legendary timepiece. He invented the first watch with an automatic mechanical drive. These innovative movements required no batteries and never needed to be manually wound. Only seven of these ultra-rare watches were ever made and we've studied the one surviving masterpiece in a watch history museum. Inspired by history, classic design and technology, our Stauer *Meisterzeit II* has been painstakingly handcrafted to meet the demanding standards of vintage watch collectors.

Why the new "antique" is better than the original. The original timepiece was truly innovative, but, as we studied it closely, we realized that we could engineer ours with a much higher level of precision. The 27-ruby-jewel movement utilizes an automatic self-winding mechanism inspired by a patent from 1923, but built on \$31 million in state-of-the-art Swiss-made machinery. With an exhibition back, you can see into the heart of the engineering and view the rotor spin—it's powered by the movement of your body.

This limited edition Stauer *Meisterzeit II* allows you to wear a watch far more exclusive than most new "upscale" models. Here is your chance to claim a piece of watchmaking history in a rare design that is priced to wear everyday.

Elegant and accurate. This refined beauty has a fastidious side. Each movement and engine-turned rotor is tested for 15 days and then certified before it leaves the factory.

The best part is that with our special price, you can wear a superb classic historical reproduction watch and laugh all the way to the bank. Stauer specializes in classic timeless watches and jewelry that are made for the millionaires who want to keep their millions. This watch will quickly move to heirloom status in your household.



View the precision movement of the *Meisterzeit* through the rear exhibition port.

Try it for 30 days and if you are not thrilled with the beauty and construction of the *Meisterzeit II*, simply return it for a refund of the purchase price.

Only 4,999 available. Since it takes about 6 months to build each watch, the release is a limited edition, so please be sure to order yours soon.

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- Precision 27-jeweled movement
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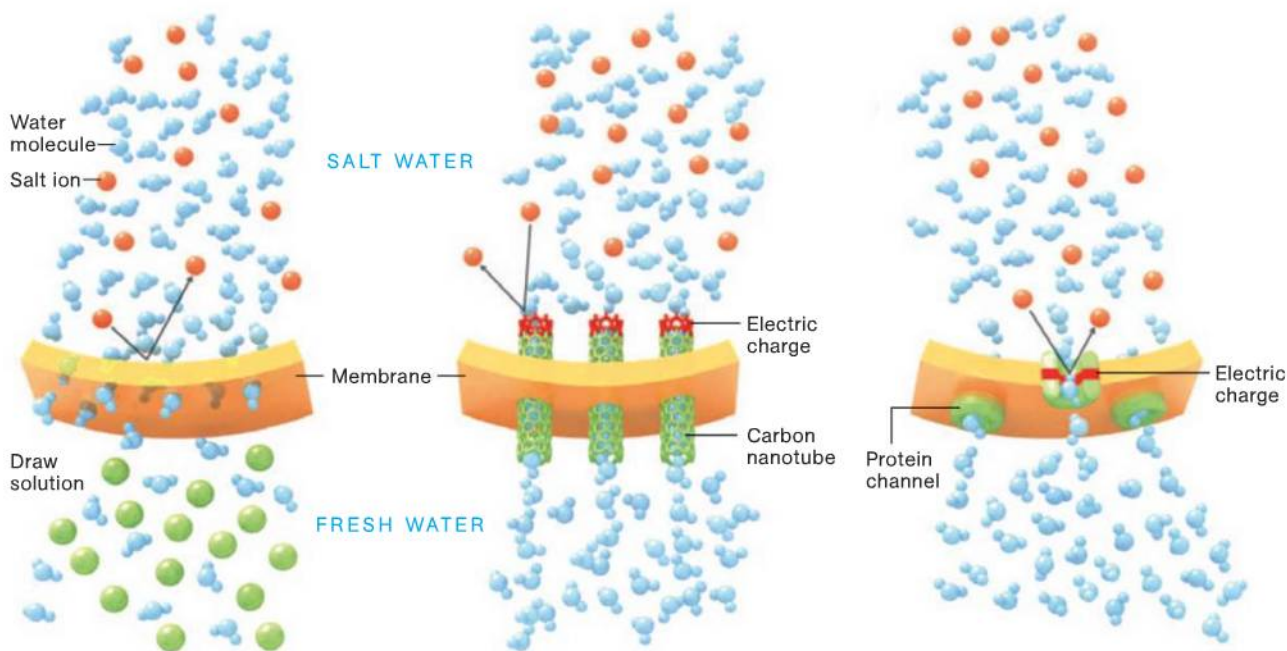
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Smart Luxuries—Surprising Prices

THE BIG IDEA (continued)

Three technologies promise to reduce the energy requirements of desalination by up to 30 percent. The race is on to see which will take the lead.



FORWARD OSMOSIS

Water molecules migrate by natural osmosis, without energy input, into an even more concentrated “draw solution,” whose special salt (green) is then evaporated away by low-grade heat.

On the market: 2010-2012

CARBON NANOTUBES

An electric charge at the nanotube mouth repels positively charged salt ions. The uncharged water molecules slip through with little friction, reducing pumping pressure.

On the market: 2013-2015

BIOMIMETICS

Water molecules pass through channels made of aquaporins, proteins that efficiently conduct water in and out of living cells. A positive charge near each channel’s center repels salt.

On the market: 2013-2015

and Perth, Australia, is reverse osmosis, in which water is forced through a membrane that catches the salt. Pumping seawater to pressures of more than a thousand pounds per square inch takes less energy than boiling it—but it is still expensive.

Researchers are now working on at least three new technologies that could cut the energy required even further. The closest to commercialization, called forward osmosis, draws water through the porous membrane into a solution that contains even more salt than seawater, but a kind of salt that is easily evaporated. The other two approaches redesign the membrane itself—one by using carbon nanotubes as the pores, the other by using the same proteins that usher water molecules through the membranes of living cells.

None of the three will be a solution for all the world’s water woes. Desalination inevitably leaves

behind a concentrated brine, which can harm the environment and even the water supply itself. Brine discharges are especially tricky to dispose of at inland desalination plants, and they’re also raising the salinity in parts of the shallow Persian Gulf. The saltier the water gets, the more expensive it becomes to desalinate.

What’s more, none of the new technologies seem simple and cheap enough to offer much hope to the world’s poor, says geologist Farouk El-Baz of Boston University. He recently attended a desalination-industry conference looking for ways to bring fresh water to the war-torn Sudanese region of Darfur. “I asked the engineers, ‘What if you are in a tiny village of 3,000, and the water is a hundred feet underground and laden with salt, and there is no electricity?’” El-Baz says. “Their mouths just dropped.” —Karen E. Lange



FRESH



WATER

The amount of moisture *on Earth has not changed.*
*The water the dinosaurs drank millions of years ago is
the same water that falls as rain today. But will there
be enough for a more crowded world?*

A summer storm replenishes Tofte Lake in northern Minnesota.

Water is life. *It's the briny broth of our origins, the pounding circulatory system of the world. We stake our civilizations on the coasts and mighty rivers. Our deepest dread is the threat of having too little—or too much.*

—BARBARA KINGSOLVER







JIM BRANDENBURG, MINDEN PICTURES (36-37); FRANS LANTING (38-40);
DICK DURRANCE II, NATIONAL GEOGRAPHIC STOCK (OPPOSITE); HANS STRAND



We keep an eye out for wonders, my daughter and I, every morning as we walk down our farm lane to meet the school bus. And wherever we find them, they reflect the magic of water: a spider web drooping with dew like a rhinestone necklace. A rain-colored heron rising from the creek bank. One astonishing morning, we had a visitation of frogs. Dozens of them hurtled up from the grass ahead of our feet, launching themselves, white-bellied, in bouncing arcs, as if we'd been caught in a downpour of amphibians. It seemed to mark the dawning of some

new aqueous age. On another day we met a snapping turtle in his primordial olive drab armor. Normally this is a pond-locked creature, but some murky ambition had moved him onto our gravel lane, using the rainy week as a passport from our farm to somewhere else.

The little, nameless creek tumbling through our hollow holds us in thrall. Before we came to southern Appalachia, we lived for years in Arizona, where a permanent runnel of that size would merit a nature preserve. In the Grand Canyon State, every license plate reminded us that water changes the face of the land, splitting open rock desert like a peach, leaving mile-deep gashes of infinite hue. Cities there function like space stations, importing every ounce of fresh water from distant rivers or fossil aquifers. But such is the human inclination to take water as a birthright that public fountains still may bubble in Arizona's town squares and farmers there raise thirsty crops. Retirees from rainier climes irrigate green lawns that impersonate the grasslands they left behind. The truth encroaches on all the fantasies, though, when desert residents wait months between rains, watching cacti tighten their belts and roadrunners skirmish over precious beads from a dripping garden faucet. Water is life. It's the briny broth of our

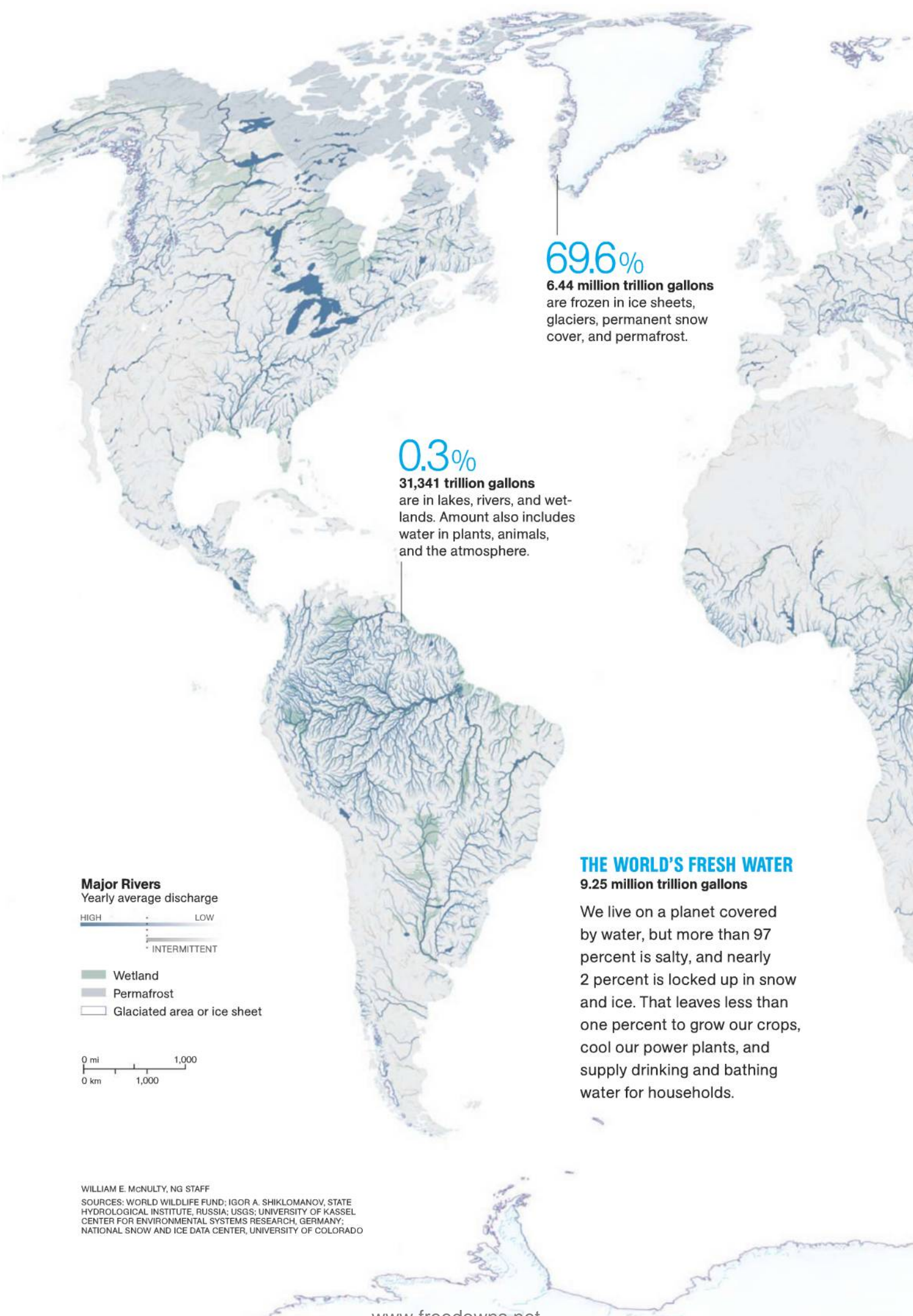
origins, the pounding circulatory system of the world, a precarious molecular edge on which we survive. It makes up two-thirds of our bodies, just like the map of the world; our vital fluids are saline, like the ocean. The apple doesn't fall far from the tree.

Even while we take Mother Water for granted, humans understand in our bones that she is the boss. We stake our civilizations on the coasts and mighty rivers. Our deepest dread is the threat of having too little moisture—or too much. We've lately raised the Earth's average temperature by .74°C (1.3°F), a number that sounds inconsequential. But these words do not: flood, drought, hurricane, rising sea levels, bursting levees. Water is the visible face of climate and, therefore, climate change. Shifting rain patterns flood some regions and dry up others as nature demonstrates a grave physics lesson: Hot air holds more water molecules than cold.

The results are in plain sight along pummeled coasts from Louisiana to the Philippines as superwarmed air above the ocean brews superstorms, the likes of which we have never known. In arid places the same physics amplify evaporation and drought, visible in the dust-dry farms of the Murray-Darling River Basin



Human babies, like the one in this swimming pool portrait, are three-quarters water.



69.6%

6.44 million trillion gallons are frozen in ice sheets, glaciers, permanent snow cover, and permafrost.

0.3%

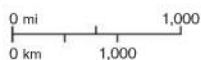
31,341 trillion gallons are in lakes, rivers, and wetlands. Amount also includes water in plants, animals, and the atmosphere.

Major Rivers

Yearly average discharge



- Wetland
- Permafrost
- Glaciated area or ice sheet

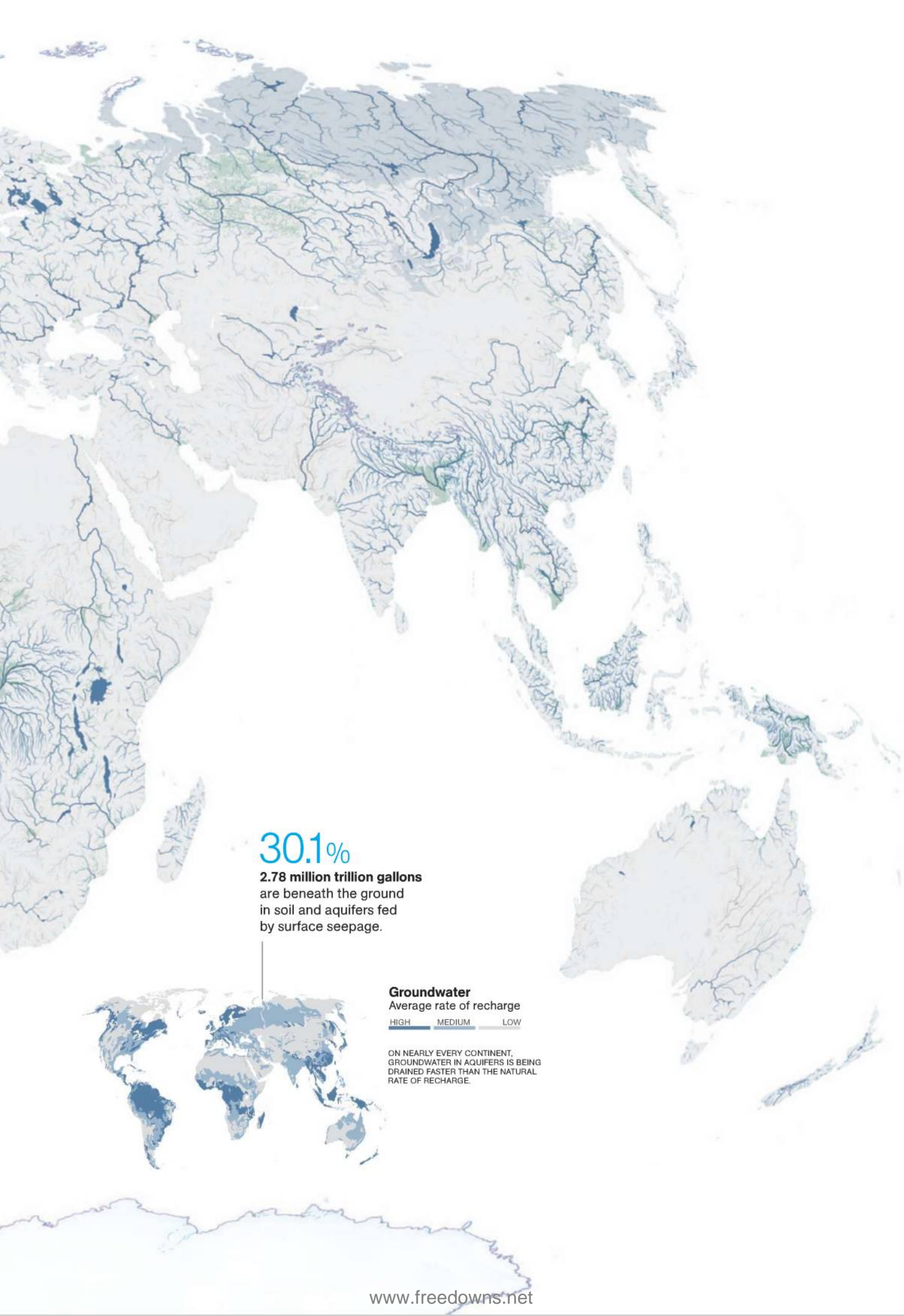


THE WORLD'S FRESH WATER

9.25 million trillion gallons

We live on a planet covered by water, but more than 97 percent is salty, and nearly 2 percent is locked up in snow and ice. That leaves less than one percent to grow our crops, cool our power plants, and supply drinking and bathing water for households.

WILLIAM E. McNULTY, NG STAFF
 SOURCES: WORLD WILDLIFE FUND; IGOR A. SHIKLOMANOV, STATE HYDROLOGICAL INSTITUTE, RUSSIA; USGS; UNIVERSITY OF KASSEL CENTER FOR ENVIRONMENTAL SYSTEMS RESEARCH, GERMANY; NATIONAL SNOW AND ICE DATA CENTER, UNIVERSITY OF COLORADO



30.1%

2.78 million trillion gallons
are beneath the ground
in soil and aquifers fed
by surface seepage.

Groundwater
Average rate of recharge
HIGH MEDIUM LOW

ON NEARLY EVERY CONTINENT,
GROUNDWATER IN AQUIFERS IS BEING
DRAINED FASTER THAN THE NATURAL
RATE OF RECHARGE.

in Australia. On top of the Himalaya, glaciers whose meltwater sustains vast populations are dwindling. The snapping turtle I met on my lane may have been looking for higher ground. Last summer brought us a string of floods that left tomatoes blighted on the vine and our farmers needing disaster relief for the third consecutive year. The past decade has brought us more extreme storms than ever before, of the kind that dump many inches in a day, laying down crops and utility poles and great sodden oaks whose roots cannot find purchase in the saturated ground. The word “disaster” seems to mock us. After enough repetitions of shocking weather, we can’t remain indefinitely shocked.

How can the world shift beneath our feet? All we know is founded on its rhythms: Water will flow from the snowcapped mountains, rain and sun will arrive in their proper seasons. Humans first formed our tongues around language, surely, for the purpose of explaining these constants to our children. What should we tell them now? That “reliable” has been rained out, or died of thirst? When the Earth seems to raise its own voice to the pitch of a gale, have we the ears to listen?

A WORLD AWAY from my damp hollow, the Bajo Piura Valley is a great bowl of the driest Holocene sands I’ve ever gotten in my shoes. Stretching from coastal, northwestern Peru into southern Ecuador, the 14,000-square-mile Piura Desert is home to many endemic forms of thorny life. Profiles of this eco-region describe it as dry to drier, and Bajo Piura on its southern edge is what anyone would call driest. Between January and March it might get close to an inch of rain, depending on the whims of El Niño, my driver explained as we bumped over the dry bed of the Río Piura, “but in some years, nothing at all.” For hours we passed through white-crust fields ruined by years of irrigation and then into eye-burning valleys

Barbara Kingsolver’s 13 published books include fiction, poetry, and creative nonfiction. Her most recent novel is The Lacuna, published in 2009.

beyond the limits of endurance for anything but sparse stands of the deep-rooted *Prosopis pallida*, arguably nature’s most arid-adapted tree. And remarkably, some scattered families of *Homo sapiens*.

They are economic refugees, looking for land that costs nothing. In Bajo Piura they find it, although living there has other costs, and fragile drylands pay their own price too, as people exacerbate desertification by cutting anything living for firewood. What brought me there, as a journalist, was an innovative reforestation project. Peruvian conservationists, partnered with the NGO Heifer International, were guiding the population into herding goats, which eat the protein-rich pods of the native mesquite and disperse its seeds over the desert. In the shade of a stick shelter, a young mother set her dented pot on a dung-fed fire and showed how she curdles goat’s milk into white cheese. But milking goats is hard to work into her schedule when she, and every other woman she knows, must walk about eight hours a day to collect water.

Their husbands were digging a well nearby. They worked with hand trowels, a plywood form for lining the shaft with concrete, inch by inch, and a sturdy hand-built crank for lowering a man to the bottom and sending up buckets of sand. A dozen hopeful men in stained straw hats stood back to let me inspect their work, which so far had yielded only a mountain of exhumed sand, dry as dust. I looked down that black hole, then turned and climbed the sand mound to hide my unprofessional tears. I could not fathom this kind of perseverance and wondered how long these beleaguered people would last before they’d had enough of their water woes and moved somewhere else.

Five years later they are still bringing up dry sand, scratching out their fate as a microcosm of life on this planet. There is nowhere else. Forty percent of the households in sub-Saharan Africa are more than a half hour from the nearest water, and that distance is growing. Australian farmers can’t follow the rainfall patterns that have shifted south to fall on the sea. A salmon that runs into a dam when homing in on her

natal stream cannot make other plans. Together we dig in, for all we're worth.

Since childhood I've heard it's possible to look up from the bottom of a well and see stars, even in daylight. Aristotle wrote about this, and so did Charles Dickens. On many a dark night the vision of that round slip of sky with stars has comforted me. Here's the only problem: It's not true. Western civilization was in no great hurry to give up this folklore; astronomers believed it for centuries, but a few of them eventually thought to test it and had their illusions dashed by simple observation.

We have been slow to give up on the myth of Earth's infinite generosity. Rather grandly, we have overdrawn our accounts.

Civilization has been similarly slow to give up on our myth of the Earth's infinite generosity. Declining to look for evidence to the contrary, we just knew it was there. We pumped aquifers and diverted rivers, trusting the twin lucky stars of unrestrained human expansion and endless supply. Now water tables plummet in countries harboring half the world's population. Rather grandly, we have overdrawn our accounts.

In 1968 the ecologist Garrett Hardin wrote a paper called "The Tragedy of the Commons," required reading for biology students ever since. It addresses the problems that can be solved only by "a change in human values or ideas of morality" in situations where rational pursuit of individual self-interest leads to collective ruin. Cattle farmers who share a common pasture, for example, will increase their herds one by one until they destroy the pasture by overgrazing. Agreeing to self-imposed limits instead, unthinkable at first, will become the right thing to do. While our laws imply that morality is fixed, Hardin made the point that "the morality of an act is a function of the state of the system at the time it is performed." Surely

it was no sin, once upon a time, to shoot and make pies of passenger pigeons.

Water is the ultimate commons. Watercourses once seemed as boundless as those pigeons that darkened the sky overhead, and the notion of protecting water was as silly as bottling it. But rules change. Time and again, from New Mexico's antique irrigation codes to the UN Convention on International Watercourses, communities have studied water systems and redefined wise use. Now Ecuador has become the first nation on Earth to put the rights of nature in its constitution so that rivers and forests are not simply property but maintain their own right to flourish. Under these laws a citizen might file suit on behalf of an injured watershed, recognizing that its health is crucial to the common good. Other nations may follow Ecuador's lead. Just as legal systems once reeled to comprehend women or former slaves as fully entitled, law schools in the U.S. are now reforming their curricula with an eye to understanding and acknowledging nature's rights.

On my desk, a glass of water has caught the afternoon light, and I'm still looking for wonders. Who owns this water? How can I call it mine when its fate is to run through rivers and living bodies, so many already and so many more to come? It is an ancient, dazzling relic, temporarily quarantined here in my glass, waiting to return to its kind, waiting to move a mountain. It is the gold standard of biological currency, and the good news is that we can conserve it in countless ways. Also, unlike petroleum, water will always be with us. Our trust in Earth's infinite generosity was half right, as every raindrop will run to the ocean, and the ocean will rise into the firmament. And half wrong, because we are not important to water. It's the other way around. Our task is to work out reasonable ways to survive inside its boundaries. We'd be wise to fix our sights on some new stars. The gentle nudge of evidence, the guidance of science, and a heart for protecting the commons: These are the tools of a new century. Taking a wide-eyed look at a watery planet is our way of knowing the stakes, the better to know our place. □





BARRY YANOWITZ

A 90-foot-high waterfall spills beneath the Brooklyn Bridge in New York City. Artist Olafur Eliasson installed the cascade in 2008 to celebrate the “physicality of water.”

NEARLY 70 PERCENT OF THE
WORLD'S FRESH WATER IS
LOCKED IN ICE • MOST OF
THE REST IS IN AQUIFERS
THAT WE'RE DRAINING
MUCH MORE QUICKLY THAN
THE NATURAL RECHARGE
RATE • TWO-THIRDS OF
OUR WATER IS USED TO
GROW FOOD • WITH 83
MILLION MORE PEOPLE ON
EARTH EACH YEAR, WATER
DEMAND WILL KEEP GOING
UP UNLESS WE CHANGE
HOW WE USE IT



Severed from the edge of Antarctica, this iceberg might float for years as it melts and releases its store of fresh water into the sea. The water molecules will eventually evaporate, condense, and recycle back to Earth as precipitation.





JOHN STANMEYER

Shiva lords over Suraj Water Park, near Mumbai, where motifs are Indian, but pleasures—splashing on a hot day—are universal. Recreation commands a growing share of water use.

AMERICANS USE ABOUT
100 GALLONS OF WATER AT
HOME EACH DAY • MILLIONS
OF THE WORLD'S POOREST
SUBSIST ON FEWER THAN
FIVE GALLONS • 46 PERCENT
OF PEOPLE ON EARTH DO
NOT HAVE WATER PIPED TO
THEIR HOMES • WOMEN IN
DEVELOPING COUNTRIES
WALK AN AVERAGE OF 3.7
MILES TO GET WATER • IN 15
YEARS, 1.8 BILLION PEOPLE
WILL LIVE IN REGIONS OF
SEVERE WATER SCARCITY



A seller of clean well water—ten cents a bag—has no problem finding a buyer in a slum in Luanda, Angola. In 2006 the prevalence of contaminated water in the city led to one of Africa's worst cholera epidemics, with 80,000 Angolans sickened.






JOHN STANMEYER

Tending body and soul, Taizo Noda, 72, bathes in the mineral-rich waters of an *onsen*, or hot spring, near Osaka, Japan. Hours spent soaking, says Noda, are “the secret of long life.”







The snowy peaks of the Himalaya—seen from 27,000 feet on Mount Everest's northern face—are part of a vital freshwater cache that courses down to a vast populace. But warming temperatures and fast-melting ice could cause disaster downstream.

NAMGYAL SHERPA, EVEREST PEACE PROJECT





In a parched Delhi slum, men swarm a tanker to siphon water—more precious than cash and gone in minutes. A Tibetan boy flings prayer cards into the Yellow River (far left) during a Buddhist ceremony in China's increasingly desertified Qinghai Province.

BY BROOK LARMER
PHOTOGRAPHS BY JONAS BENDIKSEN

THE GODS MUST BE FURIOUS.

It's the only explanation that makes sense to Jia Son, a Tibetan farmer surveying the catastrophe unfolding above his village in China's mountainous Yunnan Province. "We've upset the natural order," the devout, 52-year-old Buddhist says. "And now the gods are punishing us."

On a warm summer afternoon, Jia Son has hiked a mile and a half up the gorge that Mingyong Glacier has carved into sacred Mount Kawagebo, looming 22,113 feet high in the clouds above. There's no sign of ice, just a river roiling with silt-laden melt. For more than a century, ever since its tongue lapped at the edge of Mingyong village, the glacier has retreated like a dying serpent recoiling into its lair. Its pace has accelerated over the past decade, to more than a football field every year—a distinctly unglacial rate for an ancient ice mass.

"This all used to be ice ten years ago," Jia Son says, as he scrambles across the scree and brush. He points out a yak trail etched into the slope some 200 feet above the valley bottom. "The glacier sometimes used to cover that trail, so we had to lead our animals over the ice to get to the upper meadows."

Around a bend in the river, the glacier's snout finally comes into view: It's a deathly shade of black, permeated with pulverized rock and dirt. The water from this ice, once so pure it served in rituals as a symbol of Buddha himself, is now too loaded with sediment for the villagers



to drink. For nearly a mile the glacier's once smooth surface is ragged and cratered like the skin of a leper. There are glimpses of blue-green ice within the fissures, but the cracks themselves signal trouble. "The beast is sick and wasting away," Jia Son says. "If our sacred glacier cannot survive, how can we?"

IT IS A QUESTION that echoes around the globe, but nowhere more urgently than across the vast swath of Asia that draws its water from the "roof of the world." This geologic colossus—the highest and largest plateau on the planet, ringed by its tallest mountains—covers an area greater than western Europe, at an average altitude of more than two miles. With nearly 37,000 glaciers on the Chinese side alone, the Tibetan Plateau



Mount Everest's East Rongbuk Glacier lost some 350 vertical feet of ice between August 1921 (top) and October 2008.

and its surrounding arc of mountains contain the largest volume of ice outside the polar regions. This ice gives birth to Asia's largest and most legendary rivers, from the Yangtze and the Yellow to the Mekong and the Ganges—rivers that over the course of history have nurtured civilizations, inspired religions, and sustained ecosystems. Today they are lifelines for some of Asia's most densely settled areas, from the arid plains of Pakistan to the thirsty metropolises of northern China 3,000 miles away. All told, some two billion people in more than a dozen countries—nearly a third of the world's population—depend on rivers fed by the snow and ice of the plateau region.

But a crisis is brewing on the roof of the world, and it rests on a curious paradox: For

all its seeming might and immutability, this geologic expanse is more vulnerable to climate change than almost anywhere else on Earth. The Tibetan Plateau as a whole is heating up twice as fast as the global average of 1.3°F over the past century—and in some places even faster. These warming rates, unprecedented for at least two millennia, are merciless on the glaciers, whose rare confluence of high altitudes and low latitudes make them especially sensitive to shifts in climate.

For thousands of years the glaciers have formed what Lonnie Thompson, a glaciologist at Ohio State University, calls "Asia's freshwater bank account"—an immense storehouse whose buildup of new ice and snow (deposits) has historically offset its annual runoff (withdrawals).

Glacial melt plays its most vital role before and after the rainy season, when it supplies a greater portion of the flow in every river from the Yangtze (which irrigates more than half of China's rice) to the Ganges and the Indus (key to the agricultural heartlands of India and Pakistan).

But over the past half century, the balance has been lost, perhaps irrevocably. Of the 680 glaciers Chinese scientists monitor closely on the Tibetan Plateau, 95 percent are shedding more ice than they're adding, with the heaviest losses on its southern and eastern edges. "These glaciers are not simply retreating," Thompson says. "They're losing mass from the surface down."

Most scientists believe the worst may be yet to come. "Full-scale glacier shrinkage is inevitable," says Yao Tandong of China's Institute of Tibetan Plateau Research. "It will lead to ecological catastrophe."

The ice cover in this portion of the plateau has shrunk more than 6 percent since the 1970s—and the damage is still greater in Tajikistan and northern India, with 35 percent and 20 percent declines respectively over the past five decades.

The rate of melting is not uniform, and a number of glaciers in the Karakoram Range on the western edge of the plateau are actually advancing. This anomaly may result from increases in snowfall in the higher latitude—and therefore colder—Karakorams, where snow and ice are less vulnerable to small temperature increases. The gaps in scientific knowledge are still great, and in the Tibetan Plateau they are deepened by the region's remoteness and political sensitivity—as well as by the inherent complexities of climate science.

Brook Larmer wrote about Shanghai in the March issue. Jonas Bendiksen photographed the May 2007 story on Dharavi, a slum in Mumbai, India.

Though scientists argue about the rate and cause of glacial retreat, most don't deny that it's happening. And they believe the worst may be yet to come. The more dark areas that are exposed by melting, the more sunlight is absorbed than reflected, causing temperatures to rise faster. (Some climatologists believe this warming feedback loop could intensify the Asian monsoon, triggering more violent storms and flooding in places such as Bangladesh and Myanmar.) If current trends hold, Chinese scientists believe that 40 percent of the plateau's glaciers could disappear by 2050. "Full-scale glacier shrinkage is inevitable," says Yao Tandong, a glaciologist at China's Institute of Tibetan Plateau Research. "And it will lead to ecological catastrophe."

THE POTENTIAL IMPACTS extend far beyond the glaciers. On the Tibetan Plateau, especially its dry northern flank, people are already affected by a warmer climate. The grasslands and wetlands are deteriorating, and the permafrost that feeds them with spring and summer melt is retreating to higher elevations. Thousands of lakes have dried up. Desert now covers about one-sixth of the plateau, and in places sand dunes lap across the highlands like waves in a yellow sea. The herders who once thrived here are running out of options.

Along the plateau's southern edge, by contrast, many communities are coping with too much water. In alpine villages like Mingyong, the glacial melt has swelled rivers, with welcome side effects: expanded croplands and longer growing seasons. But such benefits often hide deeper costs. In Mingyong, surging meltwater has carried away topsoil; elsewhere, excess runoff has been blamed for more frequent flooding and landslides. In the mountains from Pakistan to Bhutan, thousands of glacial lakes have formed, many potentially unstable. Among the more dangerous is Imja Tsho, at 16,400 feet on the trail to Nepal's Island Peak. Fifty years ago the lake didn't exist; today, swollen by melt, it is a mile long and 300 feet deep. If it ever burst through its loose wall of moraine, it would drown the Sherpa villages in the valley below.

This situation—too much water, too little water—captures, in miniature, the trajectory of the overall crisis. Even if melting glaciers provide an abundance of water in the short run, they portend a frightening endgame: the eventual depletion of Asia's greatest rivers. Nobody can predict exactly when the glacier retreat will translate into a sharp drop in runoff. Whether it happens in 10, 30, or 50 years depends on local conditions, but the collateral damage across the region could be devastating. Along with acute water and electricity shortages, experts predict a plunge in food production, widespread migration in the face of ecological changes, even conflicts between Asian powers.

THE NOMADS' TENT is a pinprick of white against a canvas of green and brown. There is no other sign of human existence on the 14,000-foot-high prairie that seems to extend to the end of the world. As a vehicle rattles toward the tent, two young men emerge, their long black hair horizontal in the wind. Ba O and his brother Tsering are part of an unbroken line of Tibetan nomads who for at least a thousand years have led their herds to summer grazing grounds near the headwaters of the Yangtze and Yellow Rivers.

Inside the tent, Ba O's wife tosses patties of dried yak dung onto the fire while her four-year-old son plays with a spool of sheep's wool. The family matriarch, Lu Ji, churns yak milk into cheese, rocking back and forth in a hypnotic rhythm. Behind her are two weathered Tibetan chests topped with a small Buddhist shrine: a red prayer wheel, a couple of smudged Tibetan texts, and several yak butter candles whose flames are never allowed to go out. "This is the way we've always done things," Ba O says. "And we don't want that to change."

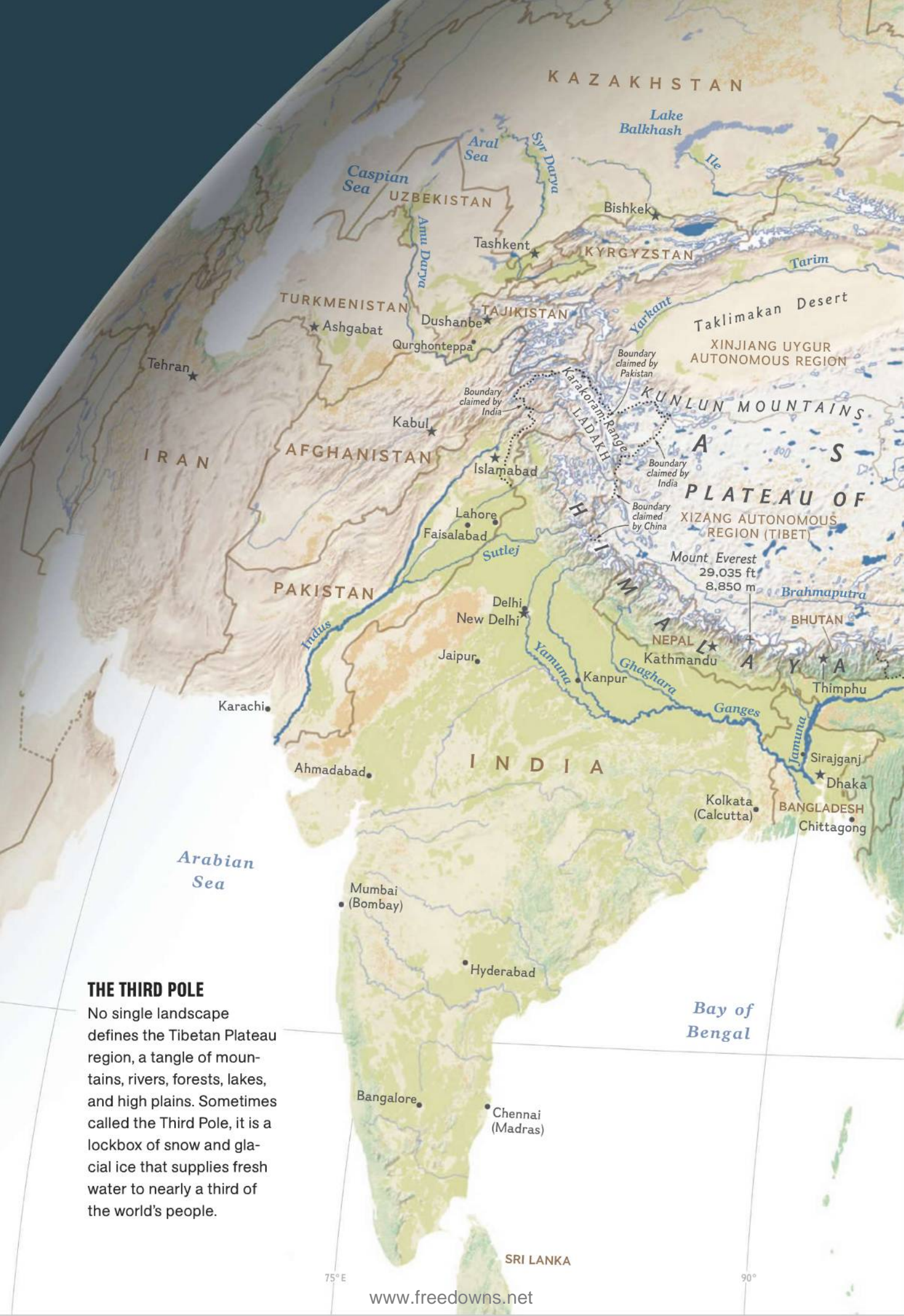
But it may be too late. The grasslands are dying out, as decades of warming temperatures—exacerbated by overgrazing—turn prairie into desert. Watering holes are drying up, and now, instead of traveling a short distance to find summer grazing for their herds, Ba O and his family must trek more than 30 miles across the high plateau. Even there the grass is meager. "It

used to grow so high you could lose a sheep in it," Ba O says. "Now it doesn't reach above their hooves." The family's herd has dwindled from 500 animals to 120. The next step seems inevitable: selling their remaining livestock and moving into a government resettlement camp.

ACROSS ASIA THE RESPONSE to climate-induced threats has mostly been slow and piecemeal, as if governments would prefer to leave it up to the industrialized countries that pumped the greenhouse gases into the atmosphere in the first place. There are exceptions. In Ladakh, a bone-dry region in northern India and Pakistan that relies entirely on melting ice and snow, a retired civil engineer named Chewang Norphel has built "artificial glaciers"—simple stone embankments that trap and freeze glacial melt in the fall for use in the early spring growing season. Nepal is developing a remote monitoring system to gauge when glacial lakes are in danger of bursting, as well as the technology to drain them. Even in places facing destructive monsoonal flooding, such as Bangladesh, "floating schools" in the delta enable kids to continue their education—on boats.

But nothing compares to the campaign in China, which has less water than Canada but 40 times more people. In the vast desert in the Xinjiang region, just north of the Tibetan Plateau, China aims to build 59 reservoirs to capture and save glacial runoff. Across Tibet, artillery batteries have been installed to launch rain-inducing silver iodide into the clouds. In Qinghai the government is blocking off degraded grasslands in hopes they can be nurtured back to health. In areas where grasslands have already turned to scrub desert, bales of wire fencing are rolled out over the last remnants of plant life to prevent them from blowing away.

Along the road near the town of Madoi are two rows of newly built houses. This is a resettlement village for Tibetan nomads, part of a massive and controversial program to relieve pressure on the grasslands near the sources of China's three major rivers—the Yangtze, Yellow, and Mekong—where (Continued on page 78)



THE THIRD POLE

No single landscape defines the Tibetan Plateau region, a tangle of mountains, rivers, forests, lakes, and high plains. Sometimes called the Third Pole, it is a lockbox of snow and glacial ice that supplies fresh water to nearly a third of the world's people.



RUSSIA

★ Ulaanbaatar

MONGOLIA

Lop Nur

Baotou

★ Beijing

Taiyuan

QINGHAI

Lanzhou

Jinan

Yellow

GRAND CANAL

Yellow Sea

TIBET

C H I N A

Xian

Zhengzhou

Nanjing

Shanghai

Mount Kawagebo
22,113 ft
6,740 m

Chengdu

Wuhan

Hangzhou

Chongqing

Nanchang

Boundary claimed by China

Mingyong

YUNNAN

Taipei

TAIWAN

MYANMAR (BURMA)

Irrawaddy

Salween

LAOS

★ Hanoi

Guangzhou

Hong Kong

Nay Pyi Taw

Vientiane

South China Sea

★ Yangon (Rangoon)

THAILAND

Mekong

★ Bangkok

CAMBODIA

VIETNAM

Phnom Penh

★ Ho Chi Minh City

- Forest
- Cropland
- Grassland
- Glacier

SCALE VARIES IN THIS PERSPECTIVE. DISTANCE FROM NEW DELHI TO DHAKA IS 890 MILES (1,432 KILOMETERS).

ALLAN CARTOGRAPHY INC. AND JEROME N. COOKSON, NG STAFF
SOURCES: ESA GLOBCOVER PROJECT; WORLD GLACIER INVENTORY AND GLOBAL LAND ICE MEASUREMENTS FROM SPACE, NATIONAL SNOW AND ICE DATA CENTER, UNIVERSITY OF COLORADO; GLOBAL RUNOFF DATA CENTRE



Bangladeshis in Sirajganj haul boatloads of bagged sand to reinforce a levee eroded by the flooding of the Jamuna River. If melting ice swells the rivers, such stopgap fixes may become more common.





An acrid haze hangs over nomads at home in a resettlement village in China's Qinghai Province (above). Cookstoves fueled with dung and wood produce black carbon, which absorbs the sun's energy and accelerates snowmelt. A power plant spewing CO₂ (below) competes for Yangtze water with family farms in Chongqing—a burgeoning municipality whose 31 million people tap the river for their needs.





Cotton supports a sleepy worker at a plant in Qurghonteppa, Tajikistan (above), and, economically, half the country's population. Rivers charged by glaciers irrigate this thirsty crop. Slum dwellers in Delhi (below) wait hours for a refill from a privately owned tap; many will be turned away. "Some have, some have not," says Syed Hasnain of Delhi's Energy and Resources Institute. "That will always be India."





A stranded bus makes a dry perch in Dhaka, where Bangladeshis slog through the capital after a downpour turns street to river. Flooding in Asia may worsen in the short term, but water shortages could eventually wreak greater havoc.



(Continued from page 69) nearly half of Qinghai Province's 530,000 nomads have traditionally lived. Tens of thousands of nomads here have had to give up their way of life, and many more—including, perhaps, Ba O—may follow.

The subsidized housing is solid, and residents receive a small annual stipend. Even so, Jixi Lamu, a 33-year-old woman in a traditional embroidered dress, says her family is stuck in limbo, dependent on government handouts. "We've spent the \$400 we had left from selling off our animals," she says. "There was no future with our herds, but there's no future here either." Her husband is away looking for menial work. Inside the one-room house, her mother sits on the bed, fingering her prayer beads. A Buddhist shrine stands on the other side of the room, but the candles have burned out.

IT IS NOT YET NOON in Delhi, just 180 miles south of the Himalayan glaciers. But in the narrow corridors of Nehru Camp, a slum in this city of 16 million, the blast furnace of the north Indian summer has already sent temperatures soaring past 105 degrees Fahrenheit. Chaya, the 25-year-old wife of a fortune-teller, has spent seven hours joining the mad scramble for water that, even today, defines life in this heaving metropolis—and offers a taste of what the depletion of Tibet's water and ice portends.

Chaya's day began long before sunrise, when she and her five children fanned out in the darkness, armed with plastic jugs of every size. After daybreak, the rumor of a tap with running water sent her stumbling in a panic through the slum's narrow corridors. Now, with her containers still empty and the sun blazing overhead, she has returned home for a moment's rest. Asked if she's eaten anything today, she laughs: "We haven't even had any tea yet."

Suddenly cries erupt—a water truck has been spotted. Chaya leaps up and joins the human torrent in the street. A dozen boys swarm onto a blue tanker, jamming hoses in and siphoning the water out. Below, shouting women jostle for position with their containers. In six minutes the tanker is empty. Chaya arrived too late and

must move on to chase the next rumor of water.

Delhi's water demand already exceeds supply by more than 300 million gallons a day, a shortfall worsened by inequitable distribution and a leaky infrastructure that loses an estimated 40 percent of the water. More than two-thirds of the city's water is pulled from the Yamuna and the Ganges, rivers fed by Himalayan ice. If that ice disappears, the future will almost certainly be worse. "We are facing an unsustainable situation," says Diwan Singh, a Delhi environmental activist. "Soon—not in thirty years but in five to ten—there will be an exodus because of the lack of water."

The tension already seethes. In the clogged alleyway around one of Nehru Camp's last functioning taps, which run for one hour a day, a man punches a woman who cut in line, leaving a purple welt on her face. "We wake up every morning fighting over water," says Kamal Bhat, a local astrologer watching the melee. This one dissolves into shouting and finger-pointing, but the brawls can be deadly. In a nearby slum a teenage boy was recently beaten to death for cutting in line.

AS THE RIVERS DWINDLE, the conflicts could spread. India, China, and Pakistan all face pressure to boost food production to keep up with their huge and growing populations. But climate change and diminishing water supplies could reduce cereal yields in South Asia by 5 percent within three decades. "We're going to see rising tensions over shared water resources, including political disputes between farmers, between farmers and cities, and between human and ecological demands for water," says Peter Gleick, a water expert and president of the Pacific Institute in Oakland, California. "And I believe more of these tensions will lead to violence."

The real challenge will be to prevent water conflicts from spilling across borders. There is already a growing sense of alarm in Central Asia over the prospect that poor but glacier-heavy nations (Tajikistan, Kyrgyzstan) may one day restrict the flow of water to their parched but oil-rich neighbors (Uzbekistan, Kazakhstan,

Turkmenistan). In the future, peace between Pakistan and India may hinge as much on water as on nuclear weapons, for the two countries must share the glacier-dependent Indus.

The biggest question mark hangs over China, which controls the sources of the region's major rivers. Its damming of the Mekong has sparked anger downstream in Indochina. If Beijing follows through on tentative plans to divert the Brahmaputra, it could provoke its rival, India, in the very region where the two countries fought a war in 1962.

For the people in Nehru Camp, geopolitical concerns are lost in the frenzied pursuit of

***"We wake up every morning fighting over water,"** says Kamal Bhate of Nehru Camp in Delhi. The brawls can be deadly. In a nearby slum a teenage boy was recently beaten to death for cutting in line.*

water. In the afternoon, a tap outside the slum is suddenly turned on, and Chaya, smiling triumphantly, hauls back a full, ten-gallon jug on top of her head. The water is dirty and bitter, and there are no means to boil it. But now, at last, she can give her children their first meal of the day: a piece of bread and a few spoonfuls of lentil stew. "They should be studying, but we keep shooing them away to find water," Chaya says. "We have no choice, because who knows if we'll find enough water tomorrow."

FATALISM MAY BE a natural response to forces that seem beyond our control. But Jia Son, the Tibetan farmer watching Mingyong Glacier shrink, believes that every action counts—good or bad, large or small. Pausing on the mountain trail, he makes a guilty confession. The melting ice, he says, may be his fault.

When Jia Son first noticed the rising temperatures—an unfamiliar trickle of sweat down his

back about a decade ago—he figured it was a gift from the gods. Winter soon lost some of its brutal sting. The glacier began releasing its water earlier in the summer, and for the first time in memory villagers had the luxury of two harvests a year.

Then came the Chinese tourists, a flood of city dwellers willing to pay locals to take them up to see the glacier. The Han tourists don't always respect Buddhist traditions; in their gleeful hollers to provoke an icefall, they seem unaware of the calamity that has befallen the glacier. Still, they have turned a poor village into one of the region's wealthiest. "Life is much easier now," says Jia Son, whose simple farmhouse, like all in the village, has a television and government-subsidized satellite dish. "But maybe our greed has made Kawagebo angry."

He is referring to the temperamental deity above his village. One of the holiest mountains in Tibetan Buddhism, Kawagebo has never been conquered, and locals believe its summit—and its glacier—should remain untouched. When a Sino-Japanese expedition tried to scale the peak in 1991, an avalanche near the top of the glacier killed all 17 climbers. Jia Son remains convinced the deaths were not an accident but an act of divine retribution. Could Mingyong's retreat be another sign of Kawagebo's displeasure?

Jia Son is taking no chances. Every year he embarks on a 15-day pilgrimage around Kawagebo to show his deepening Buddhist devotion. He no longer hunts animals or cuts down trees. As part of a government program, he has also given up a parcel of land to be reforested. His family still participates in the village's tourism cooperative, but Jia Son makes a point of telling visitors about the glacier's spiritual significance. "Nothing will get better," he says, "until we get rid of our materialistic thinking."

It's a simple pledge, perhaps, one that hardly seems enough to save the glaciers of the Tibetan Plateau—and stave off the water crisis that seems sure to follow. But here, in the shadow of one of the world's fastest retreating glaciers, this lone farmer has begun, in his own small way, to restore the balance. □



SACRED WATERS

● *From the droplets in a baptismal font to the scattering of ashes on a holy river, water blesses our lives.*

The Maya believed natural wells, such as the Xkeken cenote in Mexico's Yucatán, led to the underworld.



PHOTOGRAPHS BY JOHN STANMEYER

If I were called in / To construct a religion / I should make use of water, wrote the English poet Philip Larkin in 1954—and most religions do.

Waters, religious historian Mircea Eliade explained in the 1950s, are “spring and origin, the reservoir of all the possibilities of existence; they precede every form and support every creation.” So it has been since human history began and, by legend, before. The world, Genesis says, was brought to life by a God who created a “firmament in the midst of the waters.” Babylonians believed in a world made from a commingling of fresh and salt water. Pima Indians have said Mother Earth was impregnated by a drop of water. The cataclysmic flood that destroys a civilization is also an aqueous archetype and part of Hebrew, Greek, and Aztec cultures.

The body thirsts. So does the spirit. “I must live near a lake,” wrote Swiss psychiatrist Carl Jung, who waded into the depths of the psyche and equated water with the unconscious. “Without water, I thought, nobody could live at all.”

From our worldly entrance in a burst of amniotic fluid to the ritual washing of the dead (taharah in Judaism; *ghusl al-mayyit* in Islam), water flows through our lives, scribing a line between sacred and profane, life and death. We are doused, dunked, dipped, sprinkled—and blessings flow, deep and wide as the River Jordan of Scripture, wondrous as the spring at Lourdes, cathartic as tears. —Cathy Newman

John Stanmeyer photographed “The Global Food Crisis,” June 2009.



We worship the sources of mighty rivers; we erect altars at places where great streams burst suddenly from hidden sources; we adore springs... and consecrate certain pools.

—SENECA THE YOUNGER, 4 B.C. – A.D. 65; AD LUCILIUM EPISTULAE MORALES



A woman launches an offering on the Mekong River, known to Laotians as the "mother of waters," during Boun Pi Mai Lao, the New Year's celebration in April.





To be baptized is to be born into a new life in Christ, according to the Greek Orthodox Church. Seven-month-old Stellios Theodore Gikas is dipped three times during a ceremony at the Patriarchal Cathedral of St. George in Istanbul, Turkey.



May the waters *from the snowy mountains bring health and peace to all people. May the spring waters bring calm to you... and may the rains be a source of tranquillity to all.*

—ATHARVA VEDA, CIRCA 200 B.C.



A cross hewn for Epiphany in the ice of Maine's Kennebec River by parishioners of St. Alexander Nevsky Russian Orthodox Church commemorates the baptism of Christ. The water from the carving will bless the church. A Hasidic Jew in Ukraine (opposite) immerses himself before Rosh Hashanah in a quarry pool that serves as a mikvah, a body of water used for spiritual cleansing.





The sacred waterfall at the Tsubaki Grand Shrine in Mie Prefecture, Japan, washes away impurities in the Shinto ritual known as *misogi shuho*, which celebrates the communion among worshipper, waterfall, and the creative life force of the universe.





India's holiest river, the Ganges, is scribbled with light from floating oil lamps during the Ganga Dussehra festival in Haridwar. Hindus near death often bathe in the river; some are later cremated beside it and have their ashes scattered on its waters.



Symbol of creation, harbour of all seeds, water becomes the supreme magic and medicinal substance; it heals, it restores youth, it ensures eternal life.

—MIRCEA ELIADE, 1907-1986; *PATTERNS IN COMPARATIVE RELIGION*



Faith in the healing waters of Lourdes and hopes for a miracle attract six million pilgrims each year to the grotto in southern France where the Virgin appeared to 14-year-old Bernadette Soubirous in 1858. Muslims (opposite) perform *wudu*, the washing ritual before prayers, at Istanbul's Beyazit Mosque. "Cleanliness is half of faith," Muhammad told followers.





A pilgrim embraces the renewal granted by Saut d'Eau falls at the festival of the Virgin of Miracles in Ville Bonheur, Haiti. *Vodou* and Christianity meld as believers pray to the Virgin and welcome loa, spirits said to inhabit the waterfall.

- *If the millions of women who haul water long distances had a faucet by their door, whole societies could be transformed.*

THE BURDEN OF THIRST



Gabra women in northern Kenya spend up to five hours a day carrying heavy jerry cans filled with murky water. A lingering drought has pushed this already arid region to a water crisis.





Balancing on a slippery makeshift ladder, women pass precious gallons hand to hand up a well nine people deep in the Marsabit region of northern Kenya. After the water reaches the surface, the women will compete for it with thirsty livestock.



Rendille villagers in northern Kenya scoop the dregs from a water tank filled only the night before by a government truck but already drained below the level of its spigot. They must wait a week for the next delivery.





AYLITO BINAYO'S FEET KNOW THE MOUNTAIN.

Even at four in the morning she can run down the rocks to the river by starlight alone and climb the steep mountain back up to her village with 50 pounds of water on her back. She has made this journey three times a day for nearly all her 25 years. So has every other woman in her village of Foro, in the Konso district of southwestern Ethiopia. Binayo dropped out of school when she was eight years old, in part because she had to help her mother fetch water from the Toiro River. The water is dirty and unsafe to

drink; every year that the ongoing drought continues, the once mighty river grows more exhausted. But it is the only water Foro has ever had.

The task of fetching water defines life for Binayo. She must also help her husband grow cassava and beans in their fields, gather grass for their goats, dry grain and take it to the mill for grinding into flour, cook meals, keep the family compound clean, and take care of her three small sons. None of these jobs is as important or as consuming as the eight hours or so she spends each day fetching water.

In wealthy parts of the world, people turn on a faucet and out pours abundant, clean water. Yet nearly 900 million people in the world have no access to clean water, and 2.5 billion people have no safe way to dispose of human waste—many defecate in open fields or near the same rivers they drink from. Dirty water and lack of a toilet and proper hygiene kill 3.3 million people around the world annually, most of them children under age five. Here in southern Ethiopia, and in northern Kenya, a lack of rain over the past few years has made even dirty water elusive.

Where clean water is scarcest, fetching it is almost always women's work. In Konso a man hauls water only during the few weeks following the birth of a baby. Very young boys fetch water,

but only up to the age of seven or eight. The rule is enforced fiercely—by men and women. "If the boys are older, people gossip that the woman is lazy," Binayo says. The reputation of a woman in Konso, she says, rests on hard work: "If I sit and stay at home and do nothing, nobody likes me. But if I run up and down to get water, they say I'm a clever woman and work hard."

In much of the developing world, lack of water is at the center of a vicious circle of inequality. Some women in Foro come down to the river five times a day—with one or two of the trips devoted to getting water to make a beer-style home brew for their husbands. When I first came to Foro, some 60 men were sitting in the shade of a metal-roofed building, drinking and talking. It was midmorning. Women, says Binayo, "never get five seconds to sit down and rest."

On a hot late afternoon I go with her to the river, carrying an empty jerry can. The trail is steep and in places slippery. We scramble down large rocks alongside cacti and thornbushes. After 50 minutes we reach the river—or what is a river at certain times of the year. Now it is a series of black, muddy pools, some barely puddles. The banks and rocks are littered with the excrement of donkeys and cows. There are about 40 people at the river, enough so that Binayo

decides that the wait might be shorter upstream. The wait is especially long early in the morning, so Binayo usually makes her first trip before it is light, leaving her son Kumacho, a serious-faced little man who looks even younger than his four years, in charge of his younger brothers.

We walk another ten minutes upstream, and Binayo claims a perch next to a good pool, one fed not only by a dirty puddle just above but also a cleaner stream to the side. Children are jumping on the banks, squishing mud through their feet and stirring up the water. "Please don't jump," Binayo admonishes them. "It makes the water dirtier." A donkey steps in to drink from the puddle feeding Binayo's pool. When the donkey leaves, the women at the puddle scoop out some water to clear it, sending the dirty water down to Binayo, who scolds them.

After half an hour it is her turn. She takes her first jerry can and her yellow plastic scoop. Just as she puts her scoop in the water, she looks up to see another donkey plunk its hoof into the pool feeding hers. She grimaces. But she cannot wait any longer. She does not have the luxury of time.



An hour after we arrive at the river, she has filled two jerry cans—one for her to carry back up, one for me to carry for her. She ties a leather strap around my can and puts it on my back. I am grateful for the smooth leather—Binayo herself uses a coarse rope. Still, the straps cut into my shoulders. The plastic can is full to the top, and the 50-pound load bounces off my spine as I walk. With difficulty, I make it halfway up. But where the trail turns steepest I can go no farther. Sheepishly, I trade cans with a girl who looks to be about eight, carrying a jerry can half the size of mine. She struggles with the heavier can, and about ten minutes from the top it is too much for her. Binayo takes the heavy jerry can from the girl and puts it on her own back, on top of the one she is carrying. She shoots us both a look of disgust and continues up the mountain, now with nearly 12 gallons

of water—a hundred pounds—on her back.

"When we are born, we know that we will have a hard life," Binayo says, sitting outside a hut in her compound, in front of the cassava she is drying on a goatskin, holding Kumacho, who wears no pants. "It is the culture of Konso from a long time before us." She has never questioned this life, never expected anything different. But soon, for the first time, things are going to change.

WHEN YOU SPEND HOURS hauling water long distances, you measure every drop. The average American uses a hundred gallons of water just at home every day; Aylito Binayo makes do with two and a half gallons. Persuading people to use their water for washing is far more difficult when that water is carried up a mountain. And yet sanitation and hygiene matter—proper hand washing alone can cut diarrheal diseases by some 45 percent. Binayo washes her hands with water "maybe once a day," she says. She washes clothes once a year. "We don't even have enough water for drinking—how can we wash our clothes?" she says. She washes her own body only occasionally. A 2007 survey found that not a single Konso household had water with soap or ash (a decent cleanser) near their latrines to wash their hands. Binayo's family recently dug a latrine but cannot afford to buy soap.

Much of the cash they do have goes for four-to-eight-dollar visits to the village health clinic to cure the boys of diarrhea caused by bacteria and parasites they regularly get from the lack of proper hygiene and sanitation and from drinking untreated river water. At the clinic, nurse Israel Estiphanos said that in normal times 70 percent of his patients suffer waterborne diseases—and now the area was in the midst of a particularly severe outbreak. Next to the clinic a white tent had arisen for these patients. By my next visit, Estiphanos was attending to his patients wearing high rubber boots.

Sixteen miles away at the district health center in Konso's capital, almost half the 500 patients treated daily were sick with waterborne diseases. Yet the health center itself lacked clean water. On the walls of the staff rooms were posters

All that's left of Ethiopia's Arayo River in the dry season is a muddy seep where women "scratch" for water. But thanks to a newly built sand dam upstream, the next heavy rains will pool in an underground reservoir of clean water accessed by a hand pump.





listing the principles of infection control. But for four months a year, the water feeding their taps would run out, said Birhane Borale, the head nurse, so the government would truck in river water. "We use water then only to give to patients to drink or swallow medicine," he said. "We have HIV patients and hepatitis B patients. They are bleeding, and these diseases are easily transmittable—we need water to disinfect. But we can clean rooms only once a month."

Even medical personnel weren't in the habit of washing hands between patients, as working taps existed at only a few points in the building—most of the examining rooms had taps, but they

When clean water *becomes plentiful, all the hours previously spent hauling water can be used to grow more food, raise more animals, or even start income-producing businesses.*

were not connected. Tsega Hagos, a nurse, said she had gotten splattered with blood taking out a patient's IV. But even though there was water that day, she had not washed her hands afterward. "I just put on a different glove," she said. "I wash my hands when I get home after work."

BRINGING CLEAN WATER close to people's homes is key to reversing the cycle of misery. Communities where clean water becomes accessible and plentiful are transformed. All the hours previously spent hauling water can be used to grow more food, raise more animals, or even start income-producing businesses. Families no longer drink microbe soup, so they spend less time sick or caring for loved ones stricken with waterborne diseases. Most important, freedom from water slavery means girls can go to school and choose a better life. The need to fetch water for the family, or to take care of younger siblings while their mother goes, is the main reason very

few women in Konso have attended school. Binayo is one of only a handful of women I met who even know how old they are.

Access to water is not solely a rural problem. All over the developing world, many urban slum dwellers spend much of the day waiting in line at a pump. But the challenges of bringing water to remote villages like those in Konso are overwhelming. Binayo's village of Foro sits atop a mountain. Many villages in the tropics were built high in the hills, where it is cooler and less malarious and easier to see when the enemy is coming. But Konso's mountaintop villages do not have easy access to water. Drought and deforestation keep pushing the water table lower—in some parts of Konso it is more than 400 feet belowground. The best that can be done in some villages is to put in a well near the river. The water is no closer, but at least it is reliable, easier to extract, and more likely to be clean.

Yet in many poor nations, vast numbers of villages where wells are feasible do not have them. Boring deep holes requires geological know-how and expensive heavy machinery. Water in many countries, as in Ethiopia, is the responsibility of each district, and these local governments have little expertise or money. "People who live in slums and rural areas with no access to drinking water are the same people who don't have access to politicians," says Paul Faeth, president of Global Water Challenge, a consortium of 24 nongovernmental groups that's based in Washington, D.C. So the effort to make clean water accessible falls largely to charity groups, with mixed success.

The villages of Konso are littered with the ghosts of water projects past. In Kongsos around the developing world, the biggest problem with water schemes is that about half of them fall into disrepair soon after the groups that built them move on. Sometimes technology is used that can't be repaired locally, or spare parts are available only in the capital. But other reasons are achingly trivial: The villagers can't raise money for a three-dollar part or don't trust anyone to make the purchase with their pooled funds. The 2007 survey of Konso found that only

At a streetside laundry business in an Addis Ababa slum, Muntaha Umer earns a dollar a day washing men's clothes—only men can afford to pay—in filthy water.



nine projects out of 35 built were functioning.

Today a U.K.-based international nonprofit organization called WaterAid, one of the world's largest water-and-sanitation charities, is tackling the job of bringing water to the most forgotten villages of Konso. At the time of my visit, WaterAid had repaired five projects and set up committees in those villages to manage them, and it was working to revive three others. At the health center in Konso's capital, it was installing gutters on the sloped roofs of the buildings to conduct rainwater to a covered tank. The water is now being treated and used in the health center.

WaterAid is also working in villages like Foro, where no one has successfully brought water before. Their approach combines technologies proven to last—such as building a sand dam to capture and filter rainwater that would otherwise drain away—with new ideas like installing toilets that also generate methane gas for a new communal kitchen. But the real

innovation is that WaterAid treats technology as only part of the solution. Just as important is involving the local community in designing, building, and maintaining new water projects. Before beginning any project, WaterAid asks the community to form a WASH (water, sanitation, hygiene) committee of seven people—four of whom must be women. The committee works with WaterAid to plan projects and involve the village in construction. Then it maintains and runs the project.

The people of Konso, who grow their crops on terraces they have painstakingly dug into the sides of mountains, are famous for hard work, and they are an asset—one of Konso's few—in the quest for water. In the village of Orbesho, residents even built a road themselves so that

Writer Tina Rosenberg and photographer Lynn Johnson reported on India's village health workers in the December 2008 issue.



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Teacher Hiruut Nigusee laughs at a drawing of a man defecating—used in her hygiene classes near the Ethiopian town of Ticho. At first students were embarrassed, but now they use the latrine, wash their hands, and suffer fewer bouts of diarrhea.

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“We can do anything,” sing villagers as they dig a trench for pipes near Ticho. Their efforts—with help from WaterAid—will soon provide running water.



drilling machinery could come in. Last summer their pump, installed by the river, was being motorized to push its water to a newly built reservoir on top of a nearby mountain. From there, gravity would pipe it down to villages on the other side of the mountain. Residents of those villages had contributed a few cents apiece to help fund the project, made concrete, and collected stones for the structures, and now they were digging trenches to lay pipes.

From a distance they looked like a riotously colored snake: 200 people, mostly women in rainbow-striped peplum skirts and red or green T-shirts, forming a wavy line up the side of the mountain from the pump to the reservoir. Some men were helping lay fat pipes in the trench. The scene was almost festive with the taste of progress. Hundreds of people had come every day for four days to spend their mornings digging. The trench was about half finished, and each day the snake moved farther up the mountain.

IF INSTALLING A WATER PUMP is technically challenging, encouraging hygiene is a challenge of a different kind. Wako Lemeta is one of two hygiene promoters whom WaterAid has trained in Foro. Lemeta, rather shy and poker-faced, stops by Binayo's house and asks her husband, Guyo Jalto, if he can check their jerry cans. Jalto leads him to the hut where they are stored, and Lemeta uncovers one and sniffs. He nods approvingly; the family is using WaterGuard, a capful of which purifies a jerry can of drinking water. The government began to hand out WaterGuard at the beginning of the recent outbreak of disease. Lemeta also checks if the family has a latrine and talks to villagers about the advantages of boiling drinking water, hand washing, and bathing twice a week.

Many people have embraced the new practices. Surveys say latrine use has risen from 6 to 25 percent in the area since WaterAid began work in December 2007. But it is a struggle. “When

I tell them to use soap,” Lemeta explains, “they usually tell me, ‘Give me the money to buy it.’”

Similar barriers must be overcome to keep a program going after the aid group leaves. WaterAid and other successful groups, such as Water.org, CARE, and A Glimmer of Hope, believe that charging user fees—usually a penny per jerry can or less—is key to sustaining a project. The village WASH committee holds the proceeds to pay for spare parts and repairs. But villagers think of water as a gift from God. Should we next pay to breathe air?

Water and money have long been an uneasy mixture. Notoriously, in 1999 Bolivia granted a multinational consortium 40-year rights to provide water and sanitation services to the city of Cochabamba. The ensuing protests over high prices eventually drove out the company and brought global attention to the problems of water privatization. Multinational companies brought in to run public water systems for profit have little incentive to hook up faraway rural households or price water so it is affordable to the poor.

Yet someone has to pay for water. Although water springs from the earth, pipes and pumps, alas, do not. This is why even public utilities charge users for water. And water is often most expensive to provide for those who can least afford it—people in the remote, sparsely populated, drought-stricken villages of the world.

“The key question is, Who decides?” says Global Water Challenge’s Faeth. “In Cochabamba nobody was talking to the very poorest. The process was not open to the public.” A pump in a rural village, he says, is a different story. “At the local level there is a more direct connection between the people implementing the program and the people getting access to water.”

The Konso villagers, for instance, own and control their pumps. Elected committees set fees, which cover maintenance. No one seeks to recoup the installation costs or to make a profit. Villagers told me that, after a few weeks, they realized paying a penny per jerry can is actually cheap, far less than what they were paying through the hours spent hauling water—and the time, money, and lives lost to disease.

HOW WOULD AYLITO BINAYO’S life be different if she never had to go to the river for water again? Deep in a gorge far from Foro, there is a well. It is 400 feet deep. During my visit it was nothing much to look at—aboveground it was only a concrete box with a jerry can inverted over it for protection, surrounded by a pyramid of bramble bushes. But here’s what was to happen by March: A motorized pump would push the water up the mountain to a reservoir. Then gravity would carry it back down to taps in local villages—including Foro. The village would have two community taps and a shower house for bathing. If all went well, Aylito Binayo would have a faucet with safe water

Villagers think of water as a gift from God. But someone has to pay for it. Although water springs from the earth, pipes and pumps, alas, do not. And water is most expensive to provide for those least able to afford it.

just a three-minute stroll from her front door.

When I ask her to imagine this easier life, she closes her eyes and reels off a long list of chores. She will go the fields to help her husband, collect grass for the goats, make food for her family, clean the compound. She will be with her sons, instead of leaving a grave little four-year-old in charge of his younger brothers for hours on end. “I don’t know whether to believe it will work. We are on top of a mountain, and the water is down below,” she says. “But if it works, I will be so happy, so very happy.”

I ask her about her hopes for her family, and her answer is heartbreaking in its modesty: to get through the new hunger brought on by the drought, to get through this new wave of disease—to scramble back to the meager life she had known before. She doesn’t dream. She has never dared think that someday life could change for the better—that there could arrive a metal spigot, out of the end of which gushed dignity. □

ONE OUT OF EIGHT
PEOPLE LACKS ACCESS TO
CLEAN WATER • 3.3 MILLION
DIE FROM WATER-RELATED
HEALTH PROBLEMS EACH
YEAR • WASHING HANDS
WITH SOAP CAN REDUCE
DIARRHEAL DISEASE
BY 45 PERCENT • AN
ERADICATION CAMPAIGN
THAT INCLUDES A SIMPLE
WATER FILTER HAS CUT
THE NUMBER OF GUINEA
WORM CASES BY 99.9
PERCENT SINCE 1986

Mixing a powder made by Pur into polluted water not only kills bacteria but also makes dirt, metals, and parasites clump together so they can be filtered out, leaving crystal clear water in just 30 minutes. (Yes, our editors drank it.) Population Services International and other aid groups distribute the Purifier of Water product to help combat waterborne diseases.



COST OF WATER

The price of turning on the tap varies wildly from city to city, with water bills rarely related to whether the local environment is water-rich or how much is typically used a day. Many people believe we'd conserve more if rates were higher—and the cost is generally rising around the world. The question remains how to make clean water affordable for the poorest citizens.



JEROME COOKSON, MOLLY SNOWBERGER,
JOHN TOMANIO, NG STAFF
SOURCE: GLOBAL WATER INTELLIGENCE

Water Cost to a Consumer by Municipality

Per 100 gallons, based on roughly 4,000 gallons a month usage, U.S. dollars, 2009

Kuala Lumpur
\$0.00 to \$0.10

Gaborone
\$0.11 to \$0.25

Tijuana
\$0.26 to \$0.75

Perth
\$0.76 to \$1.75

Gent
\$1.76 to \$3.50

Tallinn
ESTONIA • \$1.11

Moscow
RUSSIA • \$0.33

Odesa
UKRAINE • \$0.17

Yerevan
ARMENIA • \$0.18

Damascus
SYRIA • \$0.03

Ramallah
WEST BANK • \$0.58

Cairo
EGYPT • \$0.03

Dubai
U.A.E. • \$0.82

Riyadh
SAUDI ARABIA • \$0.01

Muscat
OMAN • \$0.58

Addis Ababa
ETHIOPIA • \$0.09

Nairobi
KENYA • \$0.20

Kigali
RWANDA • \$0.24

Lusaka
ZAMBIA • \$0.07

Gaborone
BOTSWANA • \$0.22

Johannesburg
SOUTH AFRICA • \$0.18

Free Drinks

Politics often determine water fees. Regimes in Turkmenistan and Libya charge zero (and Cuba bills next to nothing) to burnish the leaders' power.

New Delhi's Dilemma

Low prices aim to help the poor. But the perpetually broke water utility can't afford to service the slums, whose residents then pay inflated fees to private vendors.

Heading Up

Despite water shortages, China had kept fees low to stall inflation. Rates are now rising to promote conservation.

Ulaanbaatar
MONGOLIA • \$0.08

Tashkent
UZBEKISTAN • \$0.03

Ashgabat
TURKMENISTAN • \$0.00

New Delhi
INDIA • \$0.03

Karachi
PAKISTAN • \$0.01

Kolkata
(Calcutta)
INDIA • \$0.00

Bangalore
INDIA • \$0.06

Colombo
SRI LANKA • \$0.04

Beijing
CHINA • \$0.20

Chongqing
CHINA • \$0.15

Hong Kong
CHINA • \$0.21

Hanoi
VIETNAM • \$0.06

Ho Chi Minh City
VIETNAM • \$0.13

Kuala Lumpur
MALAYSIA • \$0.09

Singapore
SINGAPORE • \$0.61

Jakarta
INDONESIA • \$0.28

Perth
AUSTRALIA • \$1.06

Sapporo
JAPAN • \$0.86

Seoul
SOUTH KOREA • \$0.22

Tokyo
JAPAN • \$0.74

Ulsan
SOUTH KOREA • \$0.30

Hiroshima
JAPAN • \$0.69

Shanghai
CHINA • \$0.12

Kumamoto
JAPAN • \$1.04

Taipei
TAIWAN • \$0.11

Manila
PHILIPPINES • \$0.16

Brisbane
AUSTRALIA • \$1.50

Sydney
AUSTRALIA • \$1.61

Melbourne
AUSTRALIA • \$1.36

Auckland
NEW ZEALAND • \$1.46



Freshwater animals are vanishing faster than those on land or at sea. But captive-breeding programs hold out hope. ●

SILENT STREAMS

Tracking the return of a native species to Tennessee's Abrams Creek, snorkeling scientists search under flat rocks for the smoky madtom—a two-inch catfish.

THIS IS A STRANGE SORT OF ARK: a brick warehouse in Knoxville, Tennessee. Not only will the thing never float, but the life-changing flood is all inside, where water pours day and night from a maze of pipes into 600 glass aquariums and plastic tubs stacked to the ceiling. The passengers, most just a few inches long, are fish: madtoms and darters, topminnows and chub. For them the carefully filtered, aerated water offers the breath of life, whereas their natural homes—streams and rivers in the southeastern United States—are choked by dams

and clouded with pollutants. The fish aboard the ark are among the last of their kind.

At the helm, sharing the role of Noah, are J. R. Shute of North Carolina and Pat Rakes of Arkansas, who met at graduate school in the mid-1980s. They've been splashing around streams and keeping aquariums since they were boys. Now they've managed to transform a boyhood passion into an unusual profession. Freshwater animals are under siege all over the planet, and the species-rich Southeast is no exception. At their Knoxville nonprofit, Conservation Fisheries, Inc. (CFI), Shute and Rakes are trying to keep some of the rarest species alive.

This is not like raising goldfish or guppies. Among the ark's passengers is the diamond darter, an imperiled sandbar dweller; it has proved so sensitive to disturbance that the biologists observe it in its aquarium only through a remote video monitor. Another darter, the Conasauga logperch, swims in a tank nearby. Its only known habitat is the Conasauga River in Georgia and Tennessee, whose waters have long been polluted and silted up by farms and factories. The Conasauga might still hold 200 of these fish, or it might not, but the three recent arrivals here are the only ones in captivity. Everyone at CFI is hoping they don't turn out to be the same sex so they can pair

off. No effort will be spared to give them the arrangement of sand, gravel, or little rock shelters that might inspire intimate relations.

Capturing the fish in the first place is just as challenging. In dive masks and bulky dry suits, talking through snorkels and wearing fish-scooping nets like hats because they need both hands free to pull themselves along the bottom, Shute and Rakes are a distinctive presence in a river. They often snorkel with flashlights at night, when some fish are more active. Once, as they splashed past a dark campground, they heard somebody holler, "Dang! Looks like a bunch of big bullfrogs with headlights."

The goal is to have seed stock ready to restore the fish to a river, if and when society restores that river to its clean, free-flowing state. It hasn't happened yet to the Conasauga, but it is happening in other streams. These days Shute and Rakes find themselves not just capturing fish to bring aboard the ark but tracking the progress of fish they have already returned to the wild. "It's a big, natural experiment, and we're learning as we go," Rakes said. "I feel very lucky to be doing something I care about so much."

LAKES, SWAMPS, AND RIVERS make up less than 0.3 percent of fresh water and less than .01 percent of all the water on Earth. Yet these waters are home to as many as 126,000 of the world's

The pallid sturgeon, one of a group of fish that has endured since dinosaur times, has now lost much of its habitat along the Missouri River. Its mustache-like barbels sense chemical traces of its prey.

SCAPHIRHYNCHUS ALBUS



animal species, including snails, mussels, crocodiles, turtles, amphibians, and fish. Almost half the 30,000 known species of fish live in lakes and rivers, and many aren't doing well; in North America, for instance, 39 percent of freshwater fish are imperiled, up from 20 percent only a few decades ago. Freshwater animals in general are disappearing at a rate four to six times as fast as animals on land or at sea. In the United States nearly half the 573 animals on the threatened and endangered list are freshwater species.

That's because freshwater ecosystems are so closely linked to human activity. Industry and agriculture are concentrated alongside flowing waters, and sooner or later the residue of virtually everything we do winds up running down the nearest creek—if we haven't dried up the creek first. In the southwestern U.S., as in other arid parts of the world, wildlife must compete for water with a burgeoning human population. Neither the Rio Grande

nor the mighty Colorado is more than a trickle at its mouth today.

But it is the American Southeast that stands out as a world center of freshwater-species diversity, especially the southern Appalachian Mountains. Carved up into countless hills and hollows that are aglitter with springs, riffles, rapids, smooth glides, and pools, the highly eroded mountains provided the isolated niches in which freshwater creatures could evolve into a multitude of forms. They also escaped the Ice Age glaciers that bulldozed much of the continent farther north. The result: The Southeast holds the grandest array of freshwater mussels on Earth; North America's premier collection of freshwater snails, crayfish, and turtles; and nearly 700 of the approximately 1,000 species and subspecies of U.S. freshwater fish.

Like most freshwater fish, those of the Southeast tend to be small and subdued in coloring—for most of the year. If you dunk your head in



Reimann's snake-necked turtle, a New Guinea native, has a seven-inch-long shell and strong jaws to crunch snails, and it smells like a skunk. "Not the prettiest snakeneck by a long way," says one scientist.

CHELODINA REIMANNI



PANGASIUS SANITWONGSEI



NOTURUS LACHNERI



Asia's giant pangasius (top left) can grow to 600 pounds, but now fish are caught before they get that big; fishing and dams have decimated the species. The finger-length Ouachita madtom (bottom left) lives only in the Saline River in Arkansas. Pollution endangers the fanshell pearlymussel (below) in the U.S. Southeast.

CYPROGENIA STEGARIA





At up to six feet long, the Chinese giant salamander is the world's largest. It secretes a slippery, foul-smelling mucus when harassed, but that doesn't keep people from eating it and using it in folk medicines.

ANDRIAS DAVIDIANUS



The hardy evergreen toad (which is often brown) climbs trees in mountains and lowlands from Nicaragua to Ecuador. Its broad range may be helping it hold on while other amphibians are vanishing.

INCILIUS CONIFERUS



during spring or summer, though, when the males assume breeding hues, you might think you were near a coral reef. Christmas darters look like swimming red-garlanded trees; holiday darters and lipstick darters are striped and flecked in turquoise and orange. Male lollypop darters have knobs along the top of their dorsal fin that swell large and bright yellow—presumably to mimic eggs and inspire females to lay some. Behaviors can be equally striking. Male madtoms—finger-length catfish with barbels extending like whiskers from around their mouths—take eggs into their mouths to clean them. Some male darters do that by fanning water over the eggs, which also supplies the eggs with oxygen. The Conasauga logperch, barely five inches long, uses its snout like a crowbar to flip pebbles in search of food.

With so many streams drowned beneath reservoirs or smothered by sediments from human activities or laden with harmful chemicals,

nearly a third of the Southeast's fish are at risk of vanishing, many within a matter of years. CFI isn't the only outfit working to preserve them. The Tennessee Aquarium in Chattanooga, other private facilities, and state and federal wildlife agencies have efforts under way as well. It's mostly thankless work. A group of independent scientists, the Southeastern Fishes Council, put together a list they call the desperate dozen—"the 12 fish most likely to become extinct soon," said Anna George, chief research scientist at the Tennessee Aquarium. "The public has never heard of most of them."

One exception is the Alabama sturgeon, which is, or was, up to 30 inches long. Its population was decimated in the past century by commercial fishing and dams that sealed off its migratory spawning routes. This sturgeon may now be the most endangered fish in the U.S. Intensive searches have turned up exactly three since it was officially protected in 2000. The last

one caught, in 2007, was given a tracking device and followed daily for two years on the chance it would lead to others. It never did, and there are no Alabama sturgeons in captivity.

In general, though, the endangered southeastern fish are of no economic importance. In some places that's precisely why they were eliminated. Tennessee's Abrams Creek, which winds for just 25 miles, mostly through Great Smoky Mountains National Park, used to hold nearly 70 species of native fish. (In contrast, the Columbia and Colorado river systems, which drain most of the American West, support only 54 species between them.) But park officials decided in 1957 to poison the native fish and stock the stream with non-native trout for sportfishing. They didn't want all those little local "baitfish" competing with young trout for food. Before long, Abrams Creek had lost nearly half of its original fish species.

Since then, however, attitudes among wildlife managers have changed. Now they want their world-class menagerie of little fish back.

ABRAMS CREEK was running clear and cool, shaded by tulip poplars, pawpaws, and pines, on the day I belly flopped in with Shute and Rakes last fall. Flotillas of crimson leaves sailed by downstream, and stripe-necked musk turtles swam over to survey us as we counted fish. From 1986 to 2002, Shute and Rakes toted bucketfuls of fish from the Knoxville ark to Abrams Creek; now they return each year to monitor the results. It's just one of more than 30 streams they are working in. Since the 1950s and '60s, attitudes—and laws—have changed outside the national parks as well. Southeastern rivers are as dammed up as ever, but after a long era of relentless logging, coal mining, and discharging from factory and sewage pipes, environmental laws have cleaned them enough that in some places, ark-raised fish can be released to test the waters.

The success stories are starting to come in. The Powell River, a tributary of the Tennessee, was devastated in 1996 by spills of coal-mine sludge, which, among other things, drastically shrank the range of the threatened yellowfin madtom. But CFI has reintroduced the fish

and helped to expand the range again. "Lately we've been finding them in 35 miles of the Powell," Rakes said. "They're doing great." And on the afternoon last fall when the CFI team and I floated down a stretch of the river in Virginia, we had plenty of other company: at least a dozen species, including chub, darters, minnows, and shiners, beaming after bits of food in the eddies that formed behind us.

Yellowfin madtoms are doing well in Abrams Creek too, as are the smoky madtoms, an endangered species that CFI also reintroduced. The spotfin chub didn't take, but Citico darters are thriving after nine years of restocking; in

Park officials *decided in 1957 to poison the native fish in Abrams Creek and stock it with trout. But attitudes among wildlife managers have changed. Now they want their world-class menagerie of little fish back.*

one hour last fall the CFI team counted 47. Later, standing among burbling aquariums in the Knoxville warehouse, Shute talked about how he had seen much worse places than Abrams Creek and about why he remains optimistic nonetheless. He described the Pigeon River, which flows from North Carolina into Tennessee.

"It was the worst of the worst around here," he said. "But the company dumping in toxic chemicals cleaned up its act. Communities improved their wastewater outflows, and we've started to reintroduce tangerine darters.

"You keep the last fish in an ark because you never know when a river might come back," Shute went on. "If the Pigeon could, any river can. They'll have to drag me out kicking and screaming before I give up." □

Douglas Chadwick and Joel Sartore are longtime contributors. Chadwick wrote recently on wolves; Sartore photographed state fairs for the July issue.

WATERWORKS

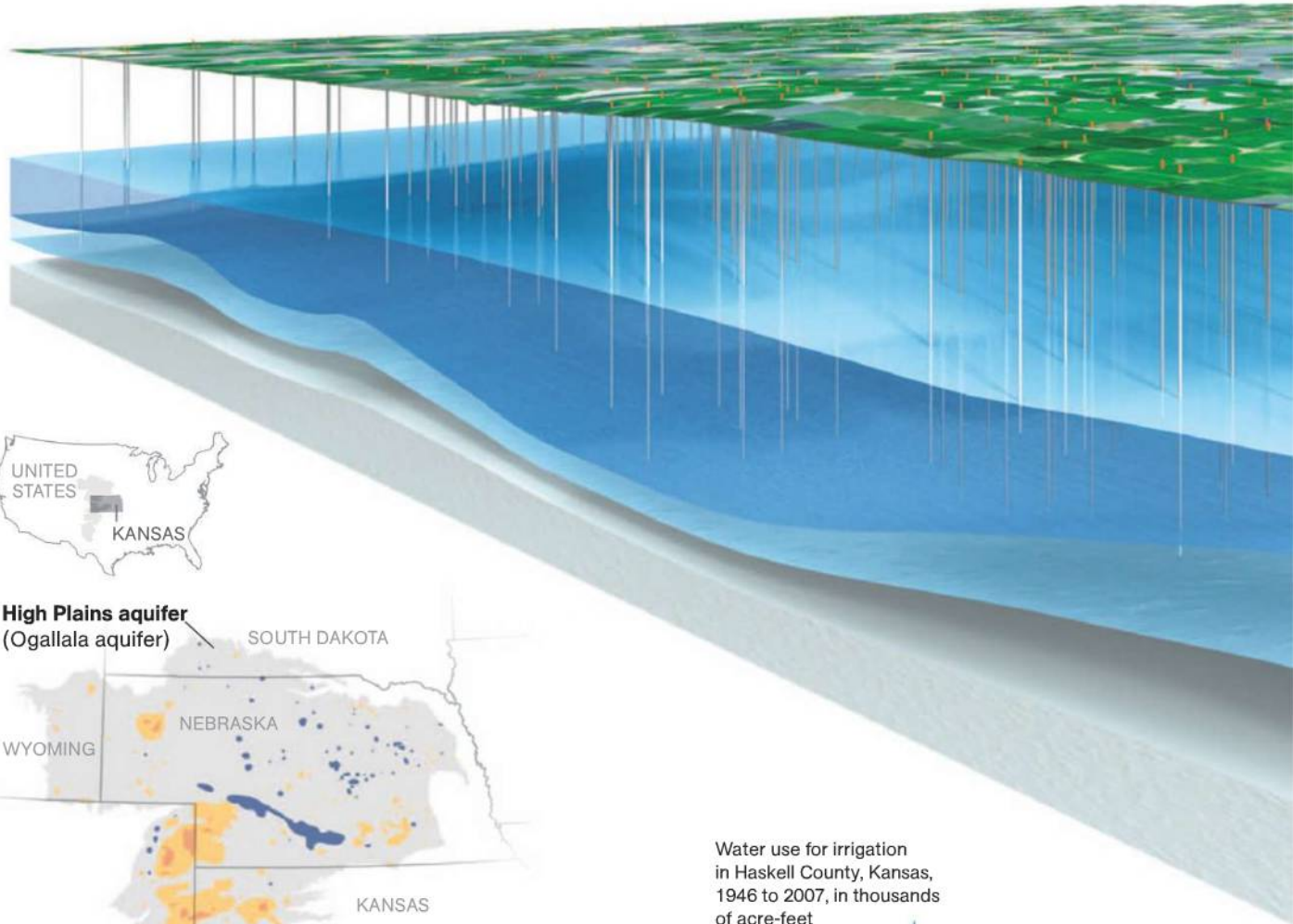
THE WEIGHT OF CHINA'S THREE GORGES RESERVOIR WILL TILT THE EARTH'S AXIS BY NEARLY AN INCH • THE LONGEST WATER TUNNEL, SUPPLYING NEW YORK CITY, IS 85 MILES AND LEAKS UP TO 35 MILLION GALLONS A DAY • THE ITAIPÚ DAM IN SOUTH AMERICA COST \$18 BILLION AND TOOK 17 YEARS TO BUILD • DAM PROJECTS HAVE DISPLACED UP TO 80 MILLION PEOPLE WORLDWIDE



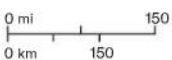
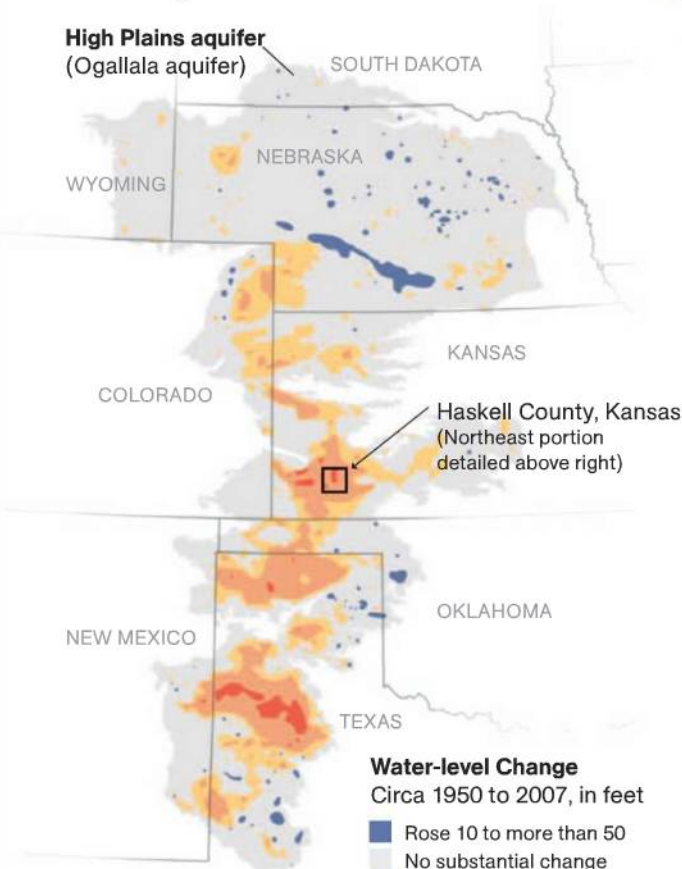
Water towers are reminders of how we engineer structures to manage this vital resource. These towers in the United Arab Emirates pressurize water to service the arid federation's plumbing.

GROUNDWATER

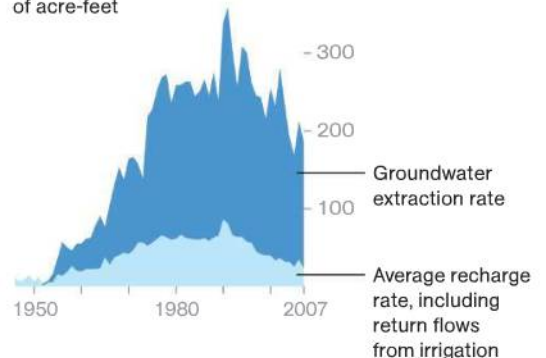
When farmers abandoned their homesteads in Haskell County, Kansas, during the 1930s Dust Bowl, they had no idea they stood atop part of the High Plains aquifer, one of America's most abundant underground reservoirs. Two decades later, water pumped from the aquifer transformed the region into the nation's breadbasket. Today



High Plains aquifer (Ogallala aquifer)



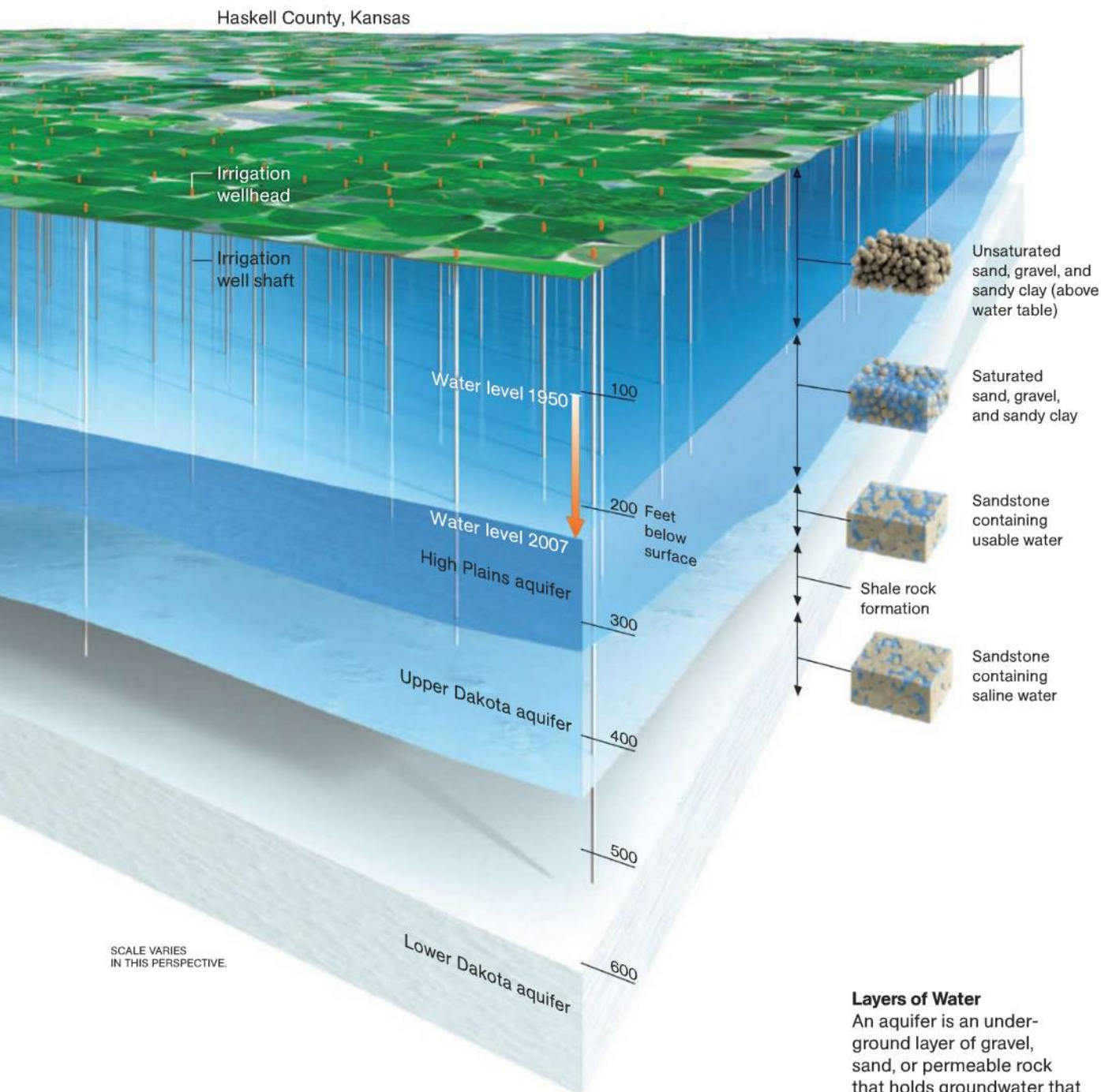
Water use for irrigation in Haskell County, Kansas, 1946 to 2007, in thousands of acre-feet



Pumping the Aquifer

Rates of aquifer depletion vary from region to region. In Kansas the decline continues despite regulation of irrigation pumping. In some other states, including Texas, pumping remains largely unchecked.

the county has about 1,100 producing wells, which nourish its \$700-million farm economy. But the withdrawal of water has greatly surpassed the aquifer's rate of natural replenishment from precipitation. In a hundred years the aquifer under most of Haskell County will be unable to support the current rate of irrigation.



Layers of Water

An aquifer is an underground layer of gravel, sand, or permeable rock that holds groundwater that can be extracted by wells. It took thousands of years for the water in the High Plains aquifer to accumulate; as it becomes depleted, it replenishes very slowly, often at a rate of less than an inch a year.

NGM ART AND MAPS
 ART: BRYAN CHRISTIE
 SOURCES: KANSAS GEOLOGICAL SURVEY AND KANSAS DEPARTMENT OF AGRICULTURE (DIAGRAM AND CHART); USGS (MAP); NASA/JPL (ASTER IMAGE)



A three-year drought has shrunk Shasta Lake to about 60 percent of its long-term level, reducing water to cities and farms.



CALIFORNIA'S
PIPE
DREAM

● *A heroic system of dams, pumps, and canals can't stave off a water crisis.*





An 82-mile-long lifeline, the All-American Canal links California's Imperial Valley to the Colorado River. This new, concrete-lined section saves 22 billion gallons of water a year over its leaky, earthen forerunner.





Tractors kick up dust in the Imperial Valley, where rainfall averages three inches a year. Irrigation enables California's farmers to grow half of all U.S. vegetables, fruits, and nuts.

Following pages:
Once the city's main water source, the Los Angeles River is now a concrete channel fed by storm drains. City residents rely on water piped in from hundreds of miles away.

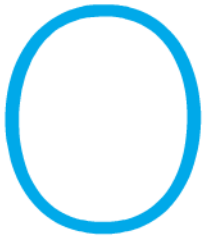






Steamboats once plied Owens Lake (above), before Los Angeles diverted the Owens River into an aqueduct. Dust from the dry lake bed is now a major source of air pollution. Southern California draws much of its water from the Sacramento-San Joaquin Delta (below), which was diked and divided into farms more than a century ago. Many of the aging levees are at risk of failure.





On a blistering day in the megalopolis that is southern California, Shivaji Deshmukh of the Orange County Water District offers me a cup of cool, clear water that just yesterday was swirling around in an Anaheim toilet bowl. We're standing outside the second largest water-reclamation facility in the world, a high-tech assemblage of micro-filters, membranes, and UV lights that every day recycles 70 million gallons of Orange

County sewage into water so clean it's almost distilled. "It's OK," Deshmukh reassures me, casually taking a slug from his own cup. "It's the same technology they use on the space station."

After spending the past century building one of the most elaborate water-delivery systems on the planet, replete with giant pumps and thousands of miles of pipes and canals, California has come to this—akin to the last desperate act of lifeboat-bound sailors drinking their own bodily fluids. The reasons are multiple and complex, but the bottom line is that the state's world-renowned plumbing is now perilously stressed. A three-year drought has drained most of the state's major reservoirs to their lowest levels in nearly two decades, forcing mandatory water restrictions for many residents. And warming temperatures have been shrinking the all-important snowpack in the Sierra Nevada, the largest storehouse of surface water in the state.

The biggest and weakest link in the system is the Sacramento-San Joaquin Delta, a former 700,000-acre marsh that has been drained, diked into islands, and farmed for more than a century. Much of the land has subsided, and many islands now sit more than 20 feet below sea level, creating California's own little slice of Holland in the middle of the Central Valley.

The delta is also the state's hydraulic heart. Water flows in through two great arteries: the Sacramento and San Joaquin Rivers. Much of it is then pumped south via two massive, man-made rivers—the Central Valley Project and the California Aqueduct—and therein lies the problem. Sea level rise combined with more severe storms now threaten to topple the weaker levees and flood the lowest islands, inundating

farmland and poisoning the big delta pumps with salt water from San Francisco Bay. A major earthquake—already overdue in the area—could take out hundreds of miles of levees in seconds, slashing water supplies for two-thirds of Californians. Experts say it could take years to put California's Humpty Dumpty hydraulics back together again.

More immediately, water exports from the delta have been partly to blame for crashing populations of protected chinook salmon and tiny delta smelt, forcing court-ordered cutbacks on water deliveries and leaving some Central Valley farms high and dry. In large protests and in lawsuits, farmers are demanding that they be given precedence over the fish. All the while the population of southern California continues to increase by more than 200,000 each year.

"The way the system works now is a disaster," says Lester Snow, California's secretary of natural resources. "The majority of water for the state's economy is coming out of critical habitat for endangered species. Every year there are more restrictions on that water."

The Sacramento-San Joaquin Delta has become such a bottleneck that last fall Governor Arnold Schwarzenegger and the California legislature hammered out the most sweeping overhaul of the state's aging water infrastructure in nearly half a century. The suite of new laws mandates water conservation and attempts to restore the delta ecosystem and secure reliable water supplies for the state's growing population. It also resurrects a proposal that's been controversial for 30 years—a giant, ten-billion-dollar ditch known as the Peripheral Canal that would bypass the delta altogether. For decades,

northern Californians have seen the mammoth project as just one more water grab by the state's crowded, parched south. Southern Californians see it as, by and large, the key to their continued prosperity and survival.

If built, the Peripheral Canal would be the latest link in a Rube Goldberg system of pumps, pipes, dams, tunnels, and canals constructed over the past century that now slake the thirst of more than two-thirds of the state's population. The system also waters nearly all the state's eight million acres of irrigated cropland as well as the tenth largest economy on Earth—in a climate that varies from temperate rain forest

A major earthquake could slash water supplies for two-thirds of Californians.

in the northwest to true desert in the south. It's probably no coincidence that Goldberg, a cartoonist famous for drawing absurdly complex machines, began his career as a water and sewer engineer for the city of San Francisco.

The reason behind the convoluted system is simple math. Roughly 70 percent of California's available water falls as rain or snow in the less populated north. Meanwhile, 80 percent of the demand lies in the southern two-thirds of the state, much of which gets just a few inches of rain a year. Former governor Pat Brown, who some 40 years ago built the California Aqueduct to connect the delta to southern California's cities, said he did so to "correct an accident of people and geography."

But as anyone familiar with the state's fractious water history will tell you, southern California's ever swelling population was no accident. Rather, it was the result of numerous audacious water projects designed to keep people coming. "The value of our homes, businesses, and the security of our jobs all depend upon an ample water supply," shouts a 1928 government film made to whip up support for an aqueduct from the Colorado River. "If we

are to survive and to grow, we must have the water that will enable us to maintain our mastery of the desert!"

That mastery began in the early 1900s, after shallow aquifers and seasonal rivers could no longer sustain Los Angeles. Out of desperation, city engineers began buying up land and water rights in the Owens Valley, east of the Sierra Nevada. In 1913 they completed the 223-mile-long Los Angeles Aqueduct, which sent the entire flow of the Owens River south to the growing city. Within a decade Owens Lake became a dust bowl, and the desert scrubland of the San Fernando Valley was worth millions.

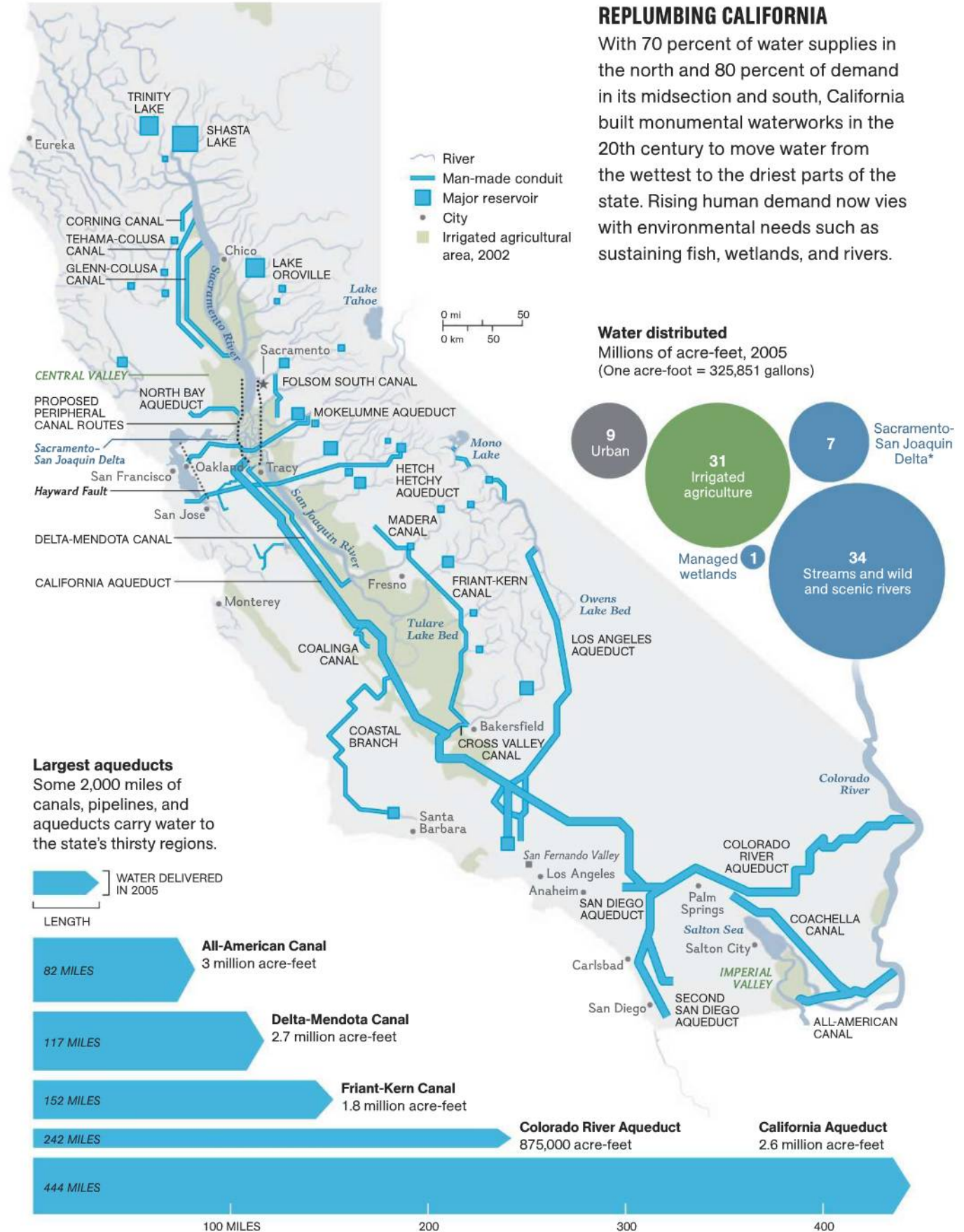
The infamous water grab—fictionalized in the 1974 film *Chinatown*—addicted Los Angeles to water imports and inspired in the rest of the state a deep-seated mistrust of the city that lingers to this day.

The heyday of California water development began in the late 1930s with construction of the colossal Central Valley Project, or CVP. To get water from the wet north to the dry south, the federal Bureau of Reclamation took advantage of the fact that the state's two largest rivers, the Sacramento and San Joaquin, funnel vast amounts of runoff from the High Sierra into a shared delta the size of Rhode Island. By building a big pumping station in the delta at Tracy and connecting it to nearly 500 miles of canals south of the delta, the CVP became a lifeline for the Central Valley. Today it waters more than 10 percent of the entire country's irrigated farmland and enables California to produce fully half the nation's fruits, nuts, and vegetables.

The 1960s brought the State Water Project (SWP), which includes the Oroville Dam, another pumping plant near Tracy, and the 444-mile-long California Aqueduct. The SWP now serves 23 million Californians, from north of the Bay Area to the Mexican border, and irrigates 755,000 acres of farmland.

The Peripheral Canal was supposed to be the system's final link, a liquid superhighway around

Joel Bourne reported on California's redwoods in the October issue. Toronto-based Edward Burtynsky specializes in photographing industrial landscapes.



*MINIMUM REQUIRED OUTFLOW
SEAN McNAUGHTON, NG STAFF
SOURCES: CALIFORNIA DEPARTMENT OF WATER RESOURCES; BUREAU OF RECLAMATION; AMERICAN FARMLAND TRUST

the delta's slow-moving twists and turns. But the state ran out of money, the federal government wanted no part of it, and the growing environmental toll of the previous big water projects sapped political support. In 1982 northern Californians defeated a referendum on the project in a landslide. It was a dead issue—until a three-year drought and a sardine-size fish brought the state to its knees.

Not since the endangered snail darter briefly held up the Tellico Dam in Tennessee during the 1970s has there been such a monumental mismatch. In one corner: the delta's two mighty pumping stations, marshaling a total of nearly half a million horsepower. In the other corner: a silvery fish that lives a year or two at best, requires plenty of cold, clean water, and exists nowhere else on Earth. A 2009 trawl survey netted the fewest smelts ever recorded—less than 2 percent of the number counted in 1993, when the fish was first declared endangered. Chinook salmon had plummeted as well. Invoking the powers of the Endangered Species Act, a federal court placed limits on the pumps at Tracy in an attempt to save the fish.

The cutbacks may have helped the salmon and smelt, but they've been disastrous for farmers such as Joe Del Bosque, whose spread lies in the hard-hit Westlands Water District, west of Fresno. Del Bosque and other Westlands farmers received notice at the start of the 2009 growing season that they would get no water from the Central Valley Project. As a result, nearly half the district—some quarter million acres—is now growing tumbleweeds and dust devils instead of cantaloupes, canning tomatoes, onions, or any of the 50 other crops usually raised in the district. Officials in the farm town of Mendota, the "Cantaloupe Center of the World," organized food drives to help the hungry as the jobless rate hit 40 percent.

The drama has fomented large protests and rants against the Endangered Species Act. But local economist Jeffrey Michael, who studies Central Valley employment at the University of the Pacific in Stockton, says the smelts aren't a major cause of the misery. A dependence on

seasonal farmwork and the shuttering of several large packing plants has caused Westlands to suffer a high jobless rate for years. "Even when they had full water allotments, unemployment was at 30 percent," Michael says.

Del Bosque, for his part, says farmers can "roll with the punches. We can roll with weather, decreasing prices, government red tape. But without water—we can't roll with that punch. It's a knockout punch for us."

The Peripheral Canal, he believes, would disentangle his water supply from the delta—and from the endangered fish. Others say it could also protect the state from another knockout punch, this time from Mother Nature, that could paralyze its vast plumbing in an instant.

THE SACRAMENTO-SAN JOAQUIN DELTA sits just east of the Hayward Fault, one of the most dangerous earthquake zones in the country. Geologists now say that the area has a two-out-of-three chance of being hit by a major quake in the next 30 years. Many of the islands in the central and western delta are protected by levees with foundations shoveled up by Chinese laborers in the late 1800s. A catastrophic earthquake could liquefy hundreds of miles of levees in a matter of seconds, allowing seawater to flood a huge swath of the delta and shutting off the pipes for months until a patch could be built.

Even without an earthquake the levees are increasingly vulnerable because of the continued subsidence and sea level rise. A run-of-the-mill winter storm in 2006 nearly flooded several islands, requiring heroic efforts to save them. In two recent reports, researchers from the Center for Watershed Sciences at the University of California, Davis, and the Public Policy Institute of California documented the extreme vulnerability of the delta, warning that the average island now has a 90 percent chance of flooding in the next 50 years.

"This is the dead meat of the delta," says Jeff Mount, an author of the reports, as he sweeps a finger across a map of some 60,000 acres of farmland. "This is going to be aquatic habitat

at some point in time, I'm 99 percent certain."

Some fisheries biologists now believe building the Peripheral Canal could also improve the delta's ecosystem—as long as the fish were guaranteed adequate water. Some of the lowest islands could be allowed to flood, providing habitat and food for smelt, salmon, and other native species. But the Peripheral Canal is still such a hot topic that it wasn't mentioned explicitly in any of the water legislation passed last fall—even as those bills opened the door for its construction. The canal's future now lies with the delta's water exporters, who must develop a plan for restoring smelt and salmon habitat before they can legally increase pumping. If their plan is approved, water agencies in the Central Valley and southern California have pledged to foot the bill for construction.

"A new canal could take the pressure off the delta, but it could also be the kiss of death—because you'd have the capacity to take all the water," says Leo Winternitz, a water-policy expert with the Nature Conservancy. "But there's an old Chinese proverb: 'Unless you change direction, you're apt to end up where you're headed.' And where we're headed in the delta is not a place we want to be."

To get a firsthand look at the fish that started all the fuss, I dropped by the University of California, Davis, smelt lab, which sits within a

she said, rather out of the blue. "But now we're running up against limits, and people don't want to think about that."

Therein lies a crucial part of the solution, water experts say, one much simpler and closer to home than a massive plumbing patch: learning to live within the water resources of an arid landscape. Fully 70 percent of residential water in southern California is used outside the home for lawns, pools, and other niceties. Reducing that demand by using drought-resistant plants and recycling wastewater offers the fastest and cheapest potential water savings in the state.

To that end, the raft of new laws passed last fall calls for cities to cut water use 20 percent by 2020. Water agencies that supply farms must develop water conservation plans and monitor groundwater usage. And in November, California voters will decide whether their state—already crippled by a \$20-billion budget deficit—should take on another \$11 billion in debt to fund new water-storage projects, conservation efforts, wastewater recycling, and desalination plants.

Even without the bond, southern Californians are focused on increasing efficiency and developing new drought-proof sources. San Diego, which pipes in 90 percent of its water, is considering following Orange County's example and opening its own wastewater-recycling facility.

*A three-year drought and a sardine-size fish have **brought the state to its knees.***

few hundred yards of the pumps that are partly responsible for the species' predicament. There, biologist Joan Lindberg is raising thousands of delta smelts in a captive-breeding program as a possible safety net against extinction. A graduate student pulled an adult smelt from a tank and held it in the palm of his hand—a frisky, wide-eyed, bullet-nosed fish that quickly leaped back into the tank.

After the brief tour I thanked Lindberg and got back in the car, but before I could drive away she ran up to my window with a concerned look on her face. "If you think about how we settled the West, it was all limitless, limitless resources,"

And the largest desalination project in the country broke ground late last year in Carlsbad, which will daily produce 50 million gallons of potable water from 100 million gallons of seawater. Despite their high cost and energy use, some 19 more plants are on the drawing board in the state.

Back in Orange County, the proffered cup of purified sewage is still in Shivaji Deshmukh's hand. The thrum of the big pumps forcing all that wastewater through the micromembranes nearby ripples the surface of the clear liquid. I take a gulp. It's bold, bright, and refreshing. It tastes like California's future. □







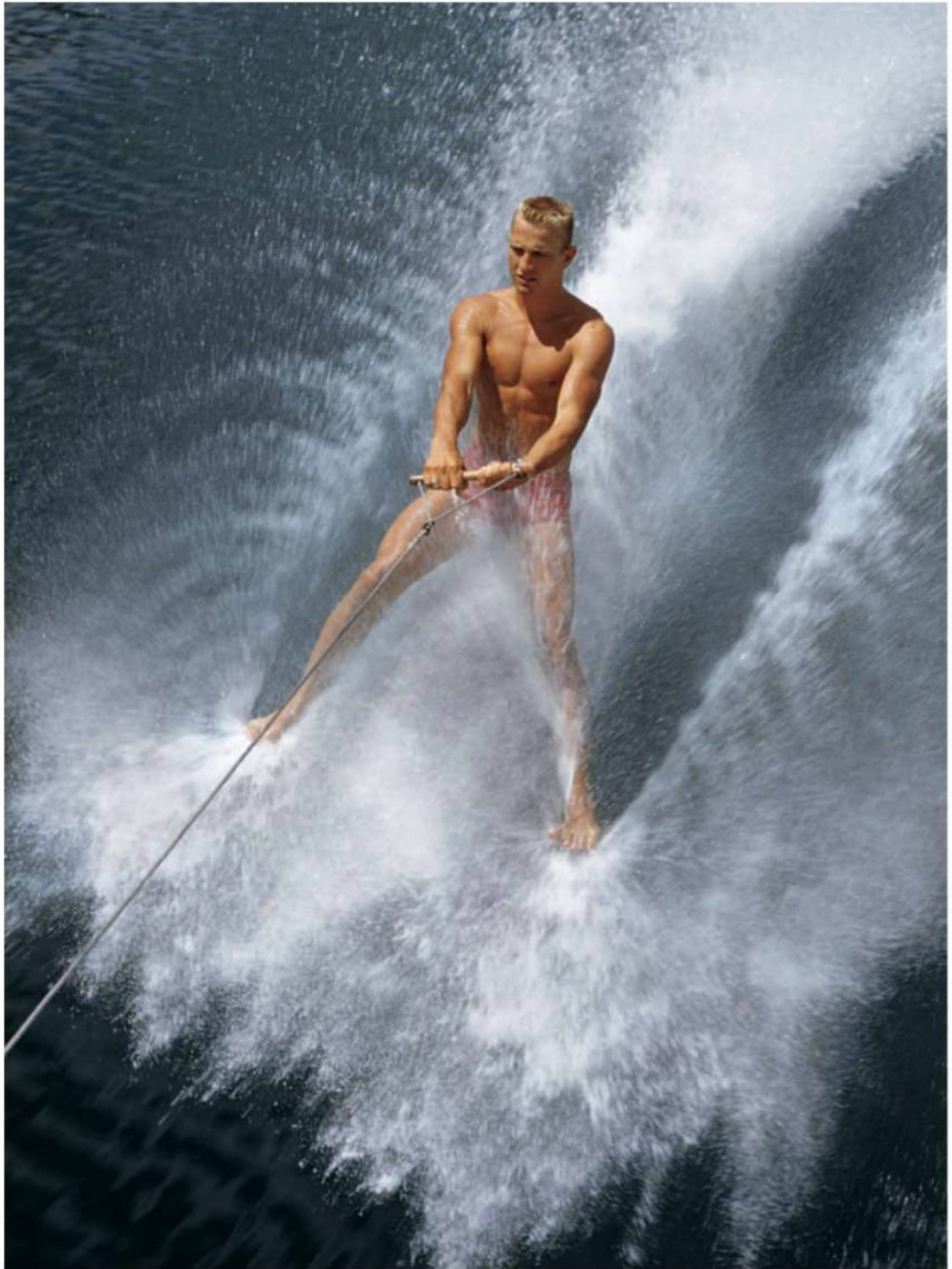


Grass is not an option in Salton City, which survives on water pumped in from the Colorado River. With 20 million more residents expected in California by 2050, the quest for water is never over.

Preceding pages: As developments such as Discovery Bay increase in the Sacramento-San Joaquin Delta, so does the flood hazard. More than a million people now live behind delta levees.

RECREATION

U.S. VACATIONERS RANK GOING TO THE BEACH OR A LAKE AS THEIR FAVORITE OUTDOOR ACTIVITY • MORE AMERICANS FISH THAN PLAY GOLF OR TENNIS • THE U.S. RECREATIONAL BOATING INDUSTRY GENERATED \$33.6 BILLION IN 2008 • IN FLORIDA, 3,000 GALLONS ARE USED TO WATER THE GRASS FOR EACH GOLF GAME PLAYED • U.S. SWIMMING POOLS LOSE 150 BILLION GALLONS TO EVAPORATION EVERY YEAR



A barefoot skier plows across a lake at Florida's Cypress Gardens in the 1950s, when the amusement park (now closed) was billed as the "Water Ski Capital of the World" and synchronized swimmer Esther Williams filmed there.

POLLUTION



2%
Diltiazem
Antihypertensive
(0.13 nanograms per gram of fish fillet tested)

46%
Norfluoxetine
Antidepressant by-product
(3.2 nanograms/gram)

Carbamazepine

Fish Pharm
These pills represent the relative amounts of four pharmaceutical drugs found in fish pulled from Chicago's North Shore Channel and tested by Baylor scientists.

*PERCENTAGES EXCEED 100 BECAUSE OF ROUNDING.
BLUE ANTIHISTAMINE PILLS (TOP) ARE NOT INCLUDED IN PERCENTAGES.
ART: OLIVER UBERTI, NG STAFF. PHOTO: REBECCA HALE, NG STAFF
SOURCE: ALEJANDRO RAMIREZ, BAYLOR UNIVERSITY

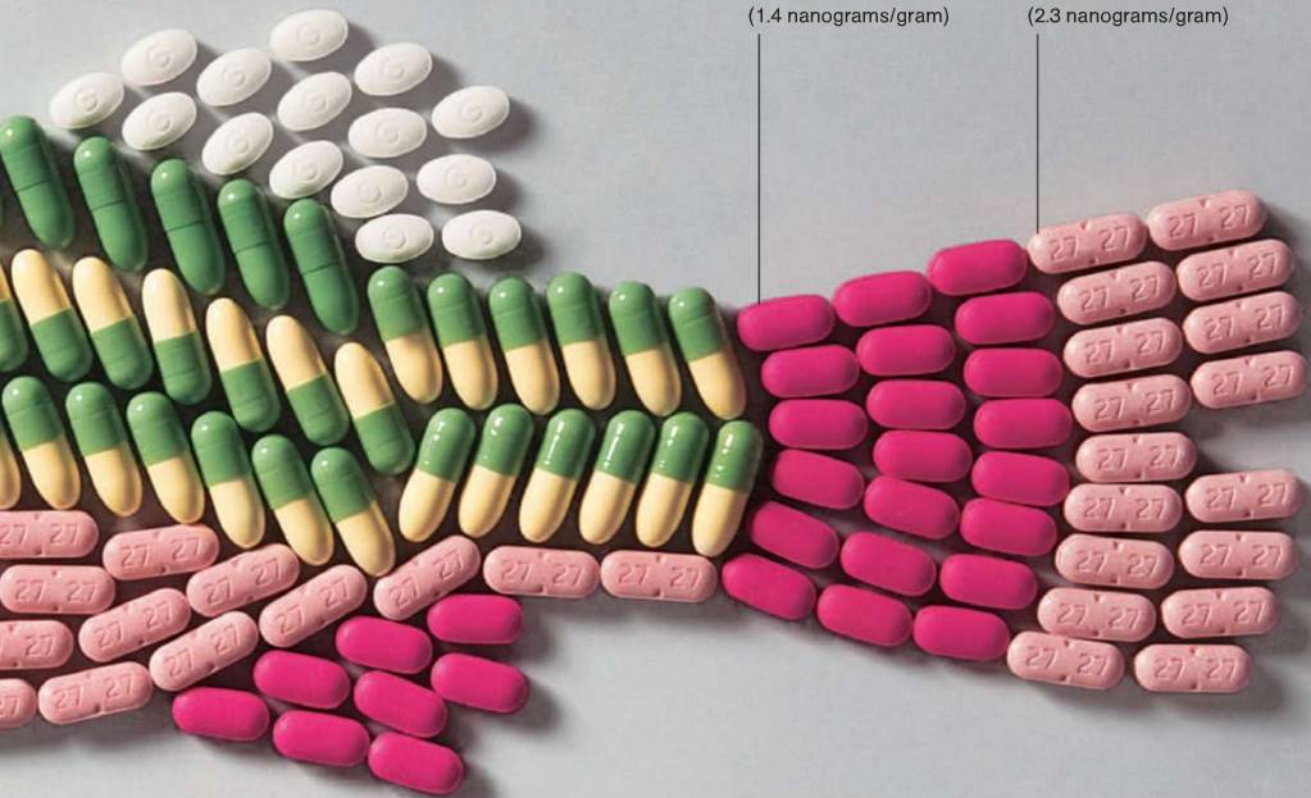


20%

Diphenhydramine
Antihistamine
(1.4 nanograms/gram)

33%*

Carbamazepine
Antiseizure
(2.3 nanograms/gram)



The traditional foe of water quality is waste from factories and farms, but now environmental regulators are eyeing a new pollution source: our medicine chests. Fish caught downstream from sewage treatment plants in five U.S. cities contained traces of pharmaceuticals and toiletries, Baylor University researchers found in a recent study. You'd have to eat tons of fish for such small concentrations to affect human health, but the products could pose a threat to marine life. To assess the risk, the EPA has expanded monitoring to 150 sites, with results due in 2011.

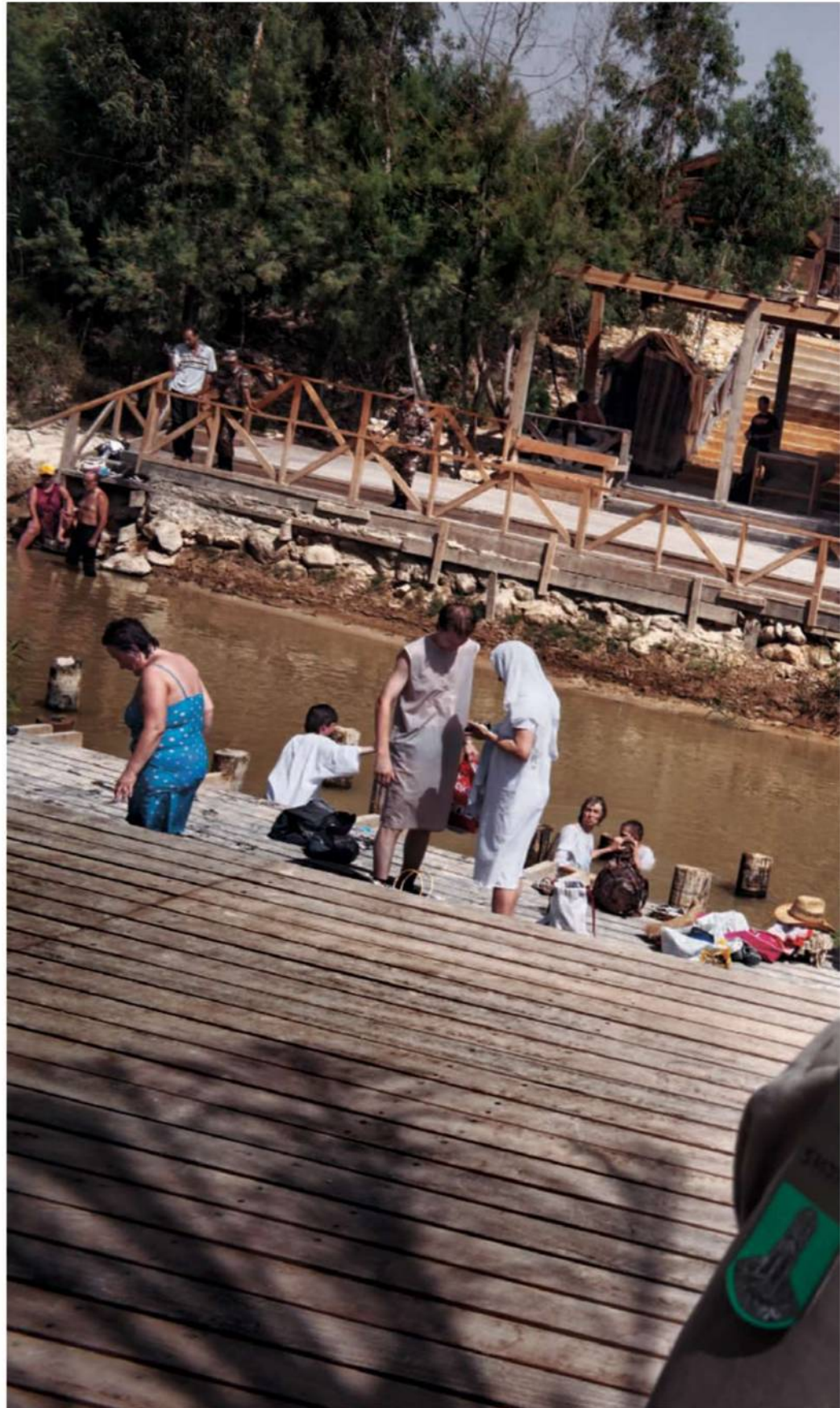


PARTING THE WATERS

● *A source of conflict between Israel and its neighbors for decades, the Jordan River is now depleted by drought, pollution, and overuse. Could the fight to save it forge a path toward peace?*

Israelis relax by the Sea of Galilee, which is fed by the Jordan River and supplies a third of Israel's fresh water. Since 1967 Israel has blocked Syria's access to the lake's shoreline.

Israeli border police (foreground) stand guard on the western bank of the lower Jordan, where pilgrims visit the river where Jesus is believed to have been baptized. On the Jordanian side, a tourist center and several churches commemorate the site.





For a biblical stream whose name evokes divine tranquility, the Jordan River is nobody's idea of peace on Earth. From its rowdy headwaters near the war-scarred slopes of Mount Hermon to the foamy, coffee-colored sludge at the Dead Sea some 200 miles downstream, the Jordan is fighting for survival in a tough neighborhood—the kind of place where nations might spike the riverbank with land mines, or go to war over a sandbar. Water has always

been precious in this arid region, but a six-year drought and expanding population conspire to make it a fresh source of conflict among the Israelis, Palestinians, and Jordanians vying for the river's life-giving supply.

All of which makes the scene one morning last July all the more remarkable. Accompanied by military escort, three scientists—an Israeli, a Palestinian, and a Jordanian—are standing knee-deep in the Jordan River. They are nearly 40 miles south of the Sea of Galilee, under the precarious ruins of a bridge that was bombed during the Six Day War of June 1967. The scientists are surveying the river for Friends of the Earth Middle East (FOEME), a regional NGO dedicated to building peace through environmental stewardship. It's a scorching hot day in a former war zone, but if these men are concerned about the danger of heat stroke, getting clonked by a chunk of falling concrete, or stepping on a mine washed downstream by a flood, they're hiding it well.

"Hey, Samer," says Sarig Gafny, an Israeli ecologist in a floppy, green hat, "check this little fellow out." Samer Talozzi, a tall, self-possessed young environmental engineer from Jordan, peers over his shoulder at the tiny invertebrate his Israeli colleague has scooped into a glass sample jar. "It lives!" he says with a laugh.

"That is one tough crustacean!" A few yards away, Banan Al Sheikh, a stout, good-natured botanist from the West Bank, is absentmindedly wading upstream while focusing his camera on a flowering tree amid the tall reeds and other riparian species along the riverbank. "Watch your step, my friend," Gafny calls out after him, "and whatever you do, don't step on a bleeping mine."

Besides lethal munitions, this stretch of the Jordan River—perhaps 25 feet wide and a few feet deep—is so polluted that any sign of aquatic life is worth celebrating. Part of the reason is water scarcity: In the past five decades the Jordan has lost more than 90 percent of its normal flow. Upstream, at the Sea of Galilee, the river's fresh waters are diverted via Israel's National Water Carrier to the cities and farms of Israel, while dams built by Jordan and Syria claim a share of the river's tributaries, mostly for agriculture. So today the lower Jordan is practically devoid of clean water, bearing instead a toxic brew of saline water and liquid waste that ranges from raw sewage to agricultural runoff, fed into the river's vein like some murky infusion of tainted blood.

The fight over the Jordan illustrates the potential for conflict over water that exists throughout the world. We live on a planet where neighbors have been clubbing each other over rivers



The Romans built pools on the Baniyas River, one of the Jordan's headwaters in the Golan Heights. Syria had sought to divert the Baniyas before Israel captured the Golan.

for thousands of years. (The word “rival,” from the Latin *rivalis*, originally described competitors for a river or stream.) Worldwide, a long list of watersheds brims with potential clashes: between India and Pakistan over the Indus; Ethiopia and Egypt over the Nile; Turkey and Syria over the Euphrates; Botswana and Namibia over the Okavango. Yet according to researchers at Oregon State University, of the 37 actual military conflicts over water since 1950, 32 took place in the Middle East; 30 of them involved Israel and its Arab neighbors. Of those, practically all were over the Jordan River and its tributaries, which supply millions of people with water for drinking, bathing, and farming.

Armed confrontations over the Jordan date to the founding of Israel in 1948 and the recognition that sources of the country's needed water supply lay outside its borders. Its survival depended on the Jordan River, with its headwaters in Syria and Lebanon, its waters stored in the Sea of Galilee, and the tributaries

that flow into it from neighboring countries.

Israel's neighbors face a similar situation. Their survival is no less at stake—which makes the line between war and peace here very fine indeed. In the 1960s Israeli air strikes after Syria attempted to divert the Baniyas River (one of the Jordan's headwaters in the Golan Heights), together with Arab attacks on Israel's National Water Carrier project, lit fuses for the Six Day War. Israel and Jordan nearly came to blows over a sandbar in the Yarmuk River in 1979. And in 2002 Israel threatened to shell agricultural pumping stations on the Hasbani, another of the headwaters in southern Lebanon.

Yet fights over water have also led to dialogue. “There are few major sources of water that don't cross one or more political boundaries,” says Gidon Bromberg, the Israeli co-director of Friends of the Earth Middle East. “That creates a natural interdependence between countries.” Sharing resources can actually be a path to peace, Bromberg says, because it forces people



Bearing the burdens of a dry land, the Jordan south of the Sea of Galilee is mostly saline water and liquid waste, its fresh waters pumped out upstream for farming and daily use.

to work together. In the 1970s, for example, Jordan and Israel agreed on how to divvy up water even when the countries were officially at war. And cooperation between Israelis and Palestinians over water has continued even as other tracks of the peace process hit a wall.

“It seems counterintuitive, but water is just too important to go to war over,” says Chuck Lawson, a former U.S. official who worked on Israeli-Palestinian water issues in the 1990s. “Regardless of the political situation, people need water, and that’s a huge incentive to work things out.”

One day last April, Bromberg led me to the natural spring that provides water to Auja, a Palestinian village of 4,500 people that climbs the barren hills a few miles west of the Jordan River near Jericho. Fed by winter rains, the spring

Don Belt is the senior editor for foreign affairs for the magazine. Paolo Pellegrin has documented conflicts in Bosnia, Sudan, and Afghanistan.







was flowing from a small, boulder-strewn oasis, and we trekked along the narrow concrete trough that transports water to the village, several miles away. “Auja is totally dependent on this water for agriculture,” Bromberg said. “As soon as this spring dries up, there’ll be no more water for farming.”

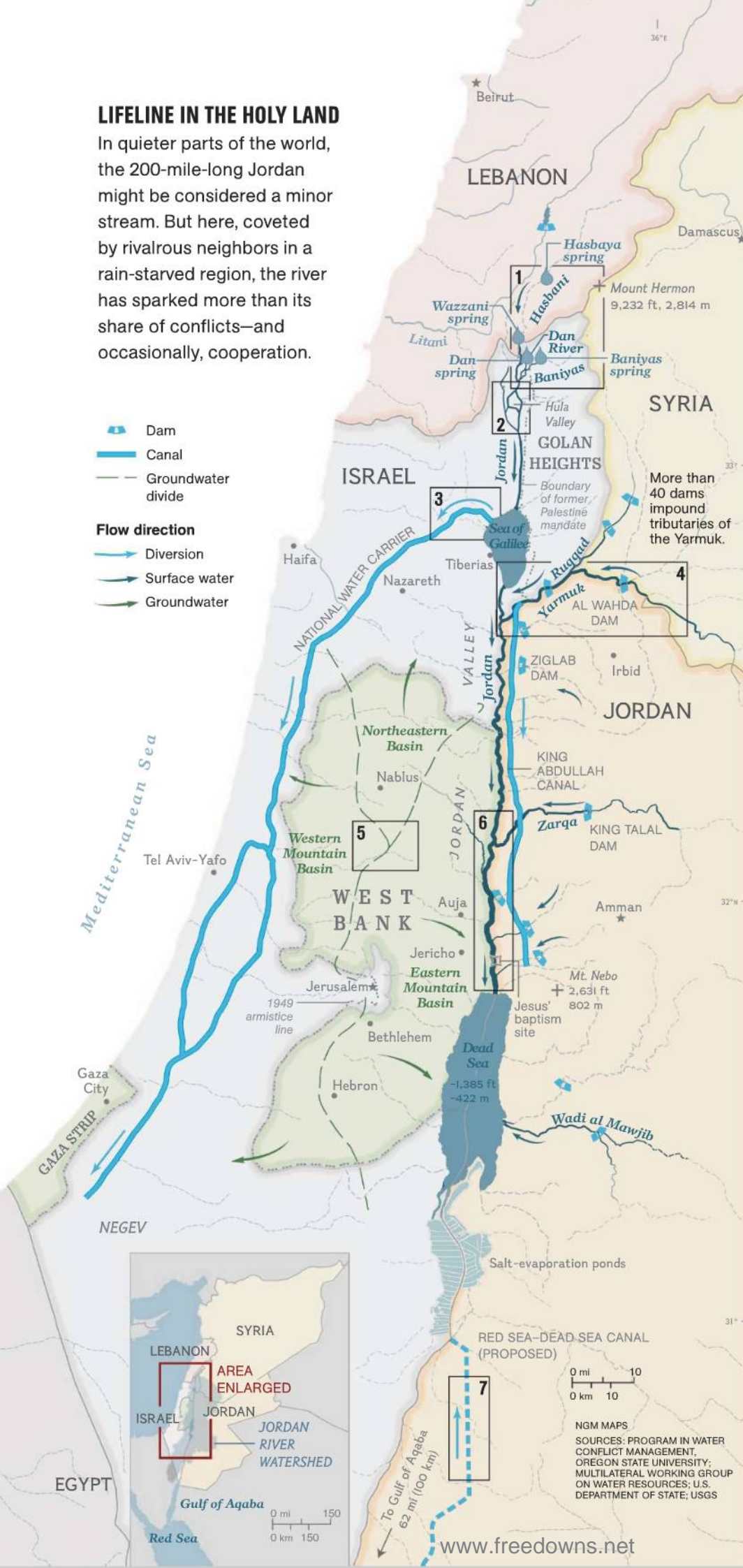
Part idealist, part political operative, Bromberg was born in Israel and raised in Australia, then returned to Israel in 1988 to help build peace in the region. By challenging his own country to share water equitably, Bromberg has rattled the cages of hard-line Israeli politicians who see water as a national security issue—and as a resource to guard jealously.

Since occupying the West Bank in 1967, Israel has built a few dozen settlements in the Jordan Valley, in addition to the 120 or so elsewhere in the West Bank. The settlers’ water is provided by Mekorot, Israel’s national water authority, which has drilled 42 deep wells in the West Bank, mainly to supply Israeli cities. (According to a

LIFELINE IN THE HOLY LAND

In quieter parts of the world, the 200-mile-long Jordan might be considered a minor stream. But here, coveted by rivalrous neighbors in a rain-starved region, the river has sparked more than its share of conflicts—and occasionally, cooperation.

-  Dam
 -  Canal
 -  Groundwater divide
- Flow direction**
-  Diversion
 -  Surface water
 -  Groundwater



1 HEADWATERS

From springs around Mount Hermon, three rivers converge in Israel to form the Jordan. After 1948 Israel treated any upstream diversion by Syria or Lebanon as a hostile act.

2 HULA VALLEY

To boost agriculture in the 1950s, Israel drained swamps bordering the Syrian Golan Heights. Skirmishes there continued until 1967, when Israel captured the Golan.

3 NATIONAL WATER CARRIER

Completed by Israel in 1964 despite fierce Arab opposition, the canal was built to move water from the Sea of Galilee to Tel Aviv and farms in the Negev desert.

4 YARMUK RIVER

Largest tributary of the Jordan, the Yarmuk is tapped by Syria, Jordan, and Israel. Secret talks between Israel and Jordan over its water foreshadowed a peace agreement in 1994.

5 GROUNDWATER

Israel's occupation of the West Bank after 1967 gave it control of the area's three major aquifers, or basins; negotiations over groundwater began during the Oslo peace talks in the 1990s.

6 LOWER JORDAN

Partly an international border and used as a waste canal, the lower Jordan is flanked by military zones and minefields and is so polluted that it hardly supports life.

7 RED SEA-DEAD SEA CANAL

Barely replenished by the Jordan, the Dead Sea has fallen to alarmingly low levels. One controversial solution: a canal connecting it to the Red Sea.



0 mi 10
0 km 10

NGM MAPS
SOURCES: PROGRAM IN WATER CONFLICT MANAGEMENT, OREGON STATE UNIVERSITY; MULTILATERAL WORKING GROUP ON WATER RESOURCES; U.S. DEPARTMENT OF STATE; USGS

After six years of drought, measuring sticks are useless at the Ziglab Dam in Jordan, built to catch water flowing west into the Jordan River for irrigation. Its reservoir has shrunk to a fifth of capacity and hasn't filled since 2003, forcing Jordan to ration water.





Swaddled against the sun, workers from Thailand harvest bananas on an Israeli kibbutz in the Jordan Valley. Though lucrative, the tropical import needs at least eight times as much water as tomatoes. "In a desert, that's crazy," says Gidon Bromberg of Friends of the Earth Middle East.







A source of friction between Israelis and Palestinians, water is emblematic of their unequal relationship. At a water park in Tiberias, Israelis bask in its relative abundance (below), while Palestinians, restricted to shallow wells by Israel's occupation, buy West Bank groundwater from Israel with European Union aid.



2009 World Bank report, Israelis use four times as much water per capita as Palestinians, much of it for agriculture. Israel disputes this, arguing that its citizens use only twice as much water and are better at conserving it.) In any case, Israel's West Bank settlements get enough water to fill their swimming pools, water their lawns, and irrigate miles of fields and greenhouses.

In contrast, West Bank Palestinians, under Israeli military rule, have been largely prevented from digging deep wells of their own, limiting their water access to shallow wells, natural springs, and rainfall that evaporates quickly in the dry desert air. When these sources run dry in the summer, Bromberg said, Auja's Palestinians have no choice but to purchase water from Israel for about a dollar a cubic yard—in effect buying back the water that's been taken out from under them by Mekorot's pumps, which also lower the water table and affect Palestinian springs and wells.

As Bromberg and I followed the Auja spring east, we passed a complex of pumps and pipes behind a barbed-wire fence—a Mekorot well, drilled 2,000 feet deep to tap the aquifer. “Blue and white pipes,” Bromberg said. “This is what water theft looks like in this part of the world.”

Israel's chief water negotiator, Noah Kinnarti, disagrees. Underground water knows no borders, he says, and points out that Israelis must also purchase the water they use. “Palestinians think any rain that falls in the West Bank belongs to them,” he told me at his kibbutz near the Sea of Galilee. “But in the Oslo talks, we agreed to share that water. They just can't get their act together to do it.”

FOEME began confronting these tough issues in 2001, during a period of intense Palestinian-Israeli violence. But by focusing first on ways to improve water quality, the NGO mobilized support and built trust through its Good Water Neighbors program, a grassroots education initiative. It's also working to establish a Jordanian-Israeli peace park on a midstream island. Perhaps most important, it has pressured governments to live up to the water-sharing commitments embedded in the region's peace agreements, seeking

to make the Jordan River a model for the kind of cooperation needed to avert future water wars.

“People all over the world associate the Jordan River with peace,” says Munqeth Mehyar, FOEME's co-director in Jordan. “We're just helping it live up to its reputation!”

When I returned to Auja in early May, its spring had been reduced to a trickle, leaving the village as dry as a fistful of talcum powder. The fields around it lay empty and exhausted, while on Auja's one plot of flat ground, boys were playing soccer amid a swirling dust cloud they were kicking up, chasing an old leather ball worn to the consistency of flannel.

Israel and its neighbors *face a similar situation: Their survival is at stake—which makes the line between war and peace very fine indeed.*

I stopped by the home of an elderly farmer named Muhammad Salama. “We haven't had running water in my house for five weeks,” Salama said. “So now I have to buy a tank of water every day from Mekorot to supply my family and to water my sheep, goats, and horses.” He also has to buy feed for his animals because there is no water to irrigate crops. To meet these costs he is selling off his livestock, and his sons have taken jobs at an Israeli settlement, tending the tomatoes, melons, and other crops irrigated from the aquifer that is off-limits to Palestinian farmers. “What can we do?” he asked, pouring me a glass of Mekorot water from a plastic bottle. “It's not fair, but we're powerless to do anything about it.”

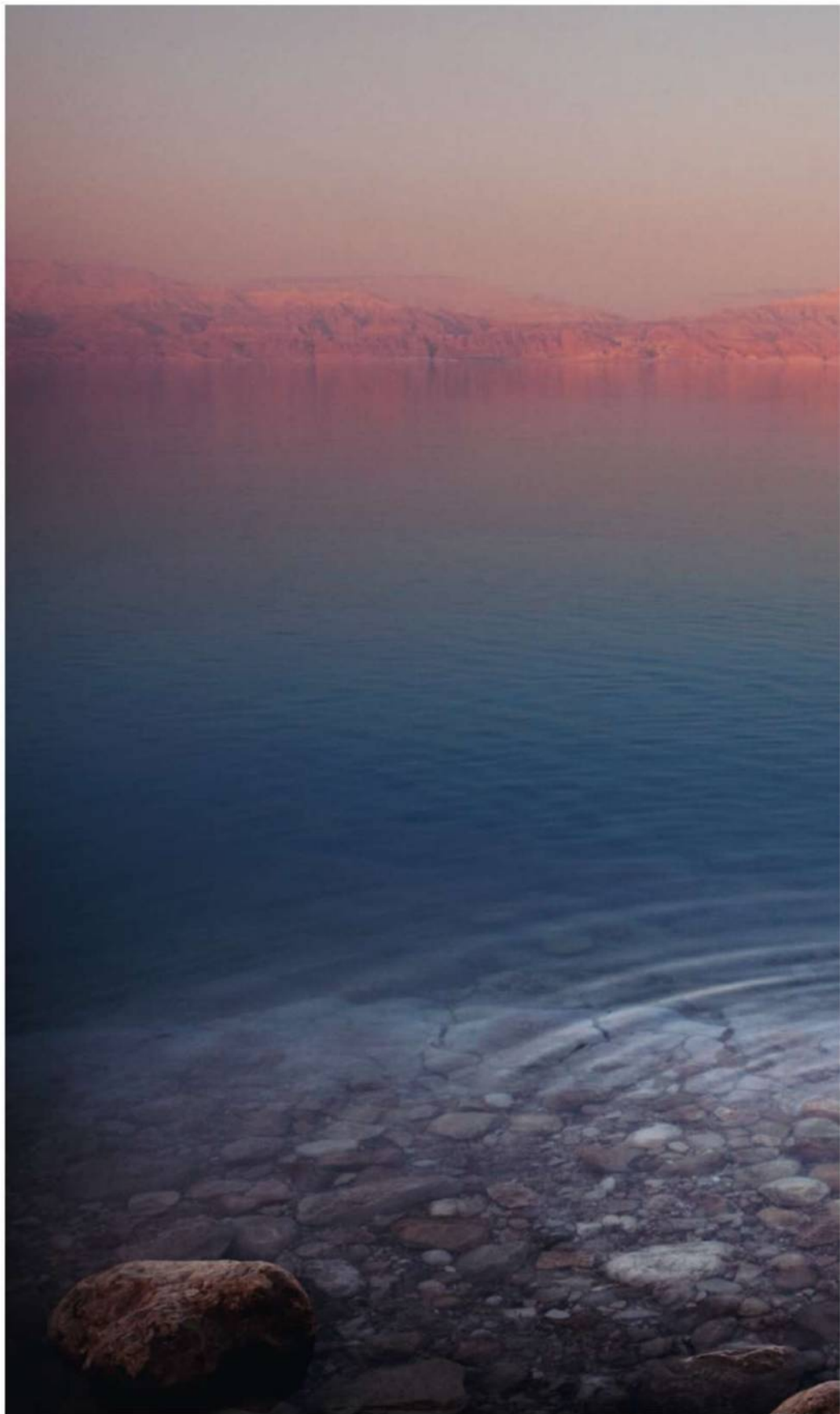
It was a clear day, and from his front window we could see across the parched, brown valley all the way to the thin line of gray-green vegetation marking the path of the Jordan River. For a moment, its water seemed within reach. “But to get there I'd have to jump an electric fence, cross a minefield, and fight the Israeli army,” Salama said. “I'd have to start a water war!” □



Tempers flare near Auja when a conversation between Israeli settlers and a local Palestinian turns to ownership of land—and water. Fed by a natural spring, Auja's only water channel for farming runs dry every summer.



Floating on dreams and whispers, girls from a West Bank village cool off in the salt-laden waters of the Dead Sea. With its main tributary, the Jordan, at less than a tenth of its former volume, the inland sea has dropped some 70 feet since 1978.





THE LAST DROP

- *We may not get all the water we want.
But we can have the water we need.*



Irrigation consumes 70 percent of fresh water. More efficient approaches like micro-sprinklers can cut use by a third.

LIVING IN THE HIGH DESERT of northern New Mexico, Louise Pape bathes three times a week, military style: wet body, turn off water, soap up, rinse, get out. She reuses her drinking cup for days without washing it, and she saves her dish-water for plants and unheated shower water to flush the toilet. While most Americans use around a hundred gallons of water a day, Pape uses just about ten.

“I conserve water because I feel the planet is dying, and I don’t want to be part of the problem,” she says.

You don’t have to be as committed an environmentalist as Pape, who edits a climate-change news service, to realize that the days of cheap and abundant water are drawing to an end. But the planet is a long way from dying of thirst. “It’s inevitable that we’ll solve our water problems,” says Peter Gleick, president of the Pacific Institute, a nonpartisan environmental think tank. “The trick is how much pain we can avoid on that path to where we want to be.”

As Gleick sees it, we’ve got two ways to go forward. Hard-path solutions focus almost exclusively on ways to develop new supplies of water, such as supersize dams, aqueducts, and pipelines that deliver water over huge distances. Gleick leans toward the soft path: a comprehensive approach that includes conservation and efficiency, community-scale infrastructure, protection of aquatic ecosystems, management at the level of watersheds instead of political boundaries, and smart economics.

Until the mid-1980s, the city of Albuquerque, some 60 miles southwest of Pape’s home in Santa Fe, was blissfully unaware that it needed to follow any path at all. Hydrogeologists believed the city sat atop an underground reservoir “as big as Lake Superior,” says Katherine Yuhas, conservation director of the Albuquerque Bernalillo County Water Utility Authority. The culture was geared toward greenery: Realtors attracted potential home buyers from moist regions with landscaping as verdant as Vermont; building codes required lawns. But then studies revealed startling news: Albuquerque’s aquifer was nowhere near the size it once appeared to

be and was being pumped out faster than rainfall and snowmelt could replenish it.

Duly alarmed, the city shifted into high gear. It revised its water-use codes, paid homeowners to take classes on reducing outdoor watering, and offered rebates to anyone who installed low-flow fixtures or a drip-irrigation system or removed a lawn. Today Albuquerque is a striving example of soft-path parsimony. Across the sprawling city, a growing number of residents and building owners funnel rainwater into barrels and underground cisterns. Almost everyone in town uses low-flow toilets and showerheads.

These efforts have shrunk Albuquerque’s domestic per capita water use from 140 gallons a day to around 80. The city “anticipates another 50 years of water, economically and sustainably supplied, even with a growing population,” says Yuhas. After that there’s the option to desalinate brackish water nearby and new technologies such as dual plumbing: one set of pipes to deliver highly treated potable water and another to recycle less treated water for flushing toilets, watering lawns, and other nonpotable uses. Albuquerque already uses wastewater—from treatment plants and from industry—to irrigate golf courses and parks. Other municipalities have gone a step further and collect wastewater—yes, from toilets—filter and disinfect it to the nth degree, then pump it back into the local aquifer for drinking. There are similar schemes worldwide: Beijing reportedly aims to reuse 100 percent of its wastewater by 2013.

Industry, too, is adapting to less certain water supplies. Frito-Lay will soon recycle almost all its water at its plant in Casa Grande, Arizona; Gatorade and Coca-Cola remove the dust and carton lint from beverage containers using air





Southwestern farmers have long shared community-operated waterways, or acequias, like the 150-year-old People's Ditch in Colorado's San Luis Valley.

JACK DYKINGA (PANORAMA COMPOSED OF SIX IMAGES)

“Water Boots,” by Roman Signer,
makes a splash and a point:
Without water, we are nothing.

instead of water; and Google recycles its own water to cool its giant data centers.

This is all reassuring—until you remember that irrigated agriculture accounts for 70 percent of the fresh water used by humans. Given this outsize proportion, it seems obvious that farmers have the greatest potential to conserve water.

Standing on the banks of a trickling ditch, Don Bustos—sunbaked and thickly bearded—demonstrates how he irrigates 130,000 dollars’ worth of produce on 3.5 acres north of Santa Fe. “I lift this board”—he points to a plank that forms a gate in the ditch—“and I shove in a stick to hold it up.” Gravity does the rest.

We learn *to live within nature’s increasingly unpredictable means, we move elsewhere, or we perish.*

For 400 years farmers in the arid Southwest have relied on such acequias—networks of community-operated ditches—to irrigate their crops. The acequia diverts water from a main stream, then further apportions the flow through sluiceways into smaller streams and onto fields. “Without the acequia, there would be no farm,” Bustos says. He’s also built a water tank with drip-irrigation hoses that feed some of the acequia water directly to the plant roots—and cut his water use by two-thirds as a consequence.

Elsewhere, forward-thinking farmers have replaced flood irrigation with micro-sprinkler systems, laser leveled their fields, and installed soil-moisture monitors to better time irrigation. In California, says the Pacific Institute, such improvements could potentially conserve roughly five million acre-feet of water a year, enough to meet the household needs of 37 million people. Unfortunately, most farmers lack the incentive to install efficient but expensive irrigation systems: Government subsidies keep farm water cheap. But experts agree that more

realistic water pricing and improved water management will significantly cut agricultural water use. One way or another, the developed world will get the water it needs, if not the water it wants. We can find new supplies—by desalinating water, recycling water, capturing and filtering storm water from paved surfaces, and redistributing water rights among agriculture, industry, and cities. Cheaply and quickly we can slash demand—with conservation and efficiency measures, with higher rates for water wasters, and with better management policies.

What about the rest of the world? In places lacerated by poverty, the problem is often a lack of infrastructure—wells, pipes, pollution controls, and systems for disinfecting water. Though politically challenging to execute, the solutions are fairly straightforward: investment in appropriately scaled technology, better governance, community involvement, proper water pricing, and training water users to maintain their systems. In regions facing scarcity because of overpumped aquifers, better management and efficiency will stretch the last drops. Farmers in southern India, for example, save fuel in addition to water when they switch from flood to drip irrigation; other communities landscape their hillsides to retain rainwater and replenish aquifers.

Still, the time is coming when some farmers—the largest water users and the lowest ratepayers—may find themselves rethinking what, or if, they should plant in the first place. In the parched Murray-Darling Basin of Australia, farmers are already packing up and moving out.

It is hardly the first time that water scarcity has created environmental refugees. A thousand years ago, less than 120 miles from modern-day Santa Fe, the inhabitants of Chaco Canyon built rock-lined ditches, headgates, and dams to manage runoff from their enormous watershed. Then, starting around A.D. 1130, a prolonged drought set in. Water scarcity may not have been the only cause, but within a few decades, Chaco Canyon had been abandoned. We hardly need reminding that nature can be unforgiving: We learn to live within her increasingly unpredictable means, we move elsewhere, or we perish. □

Elizabeth Royte’s latest book is Bottlemania, about the uncertain future of America’s drinking water.





ON ASSIGNMENT **Worth the Wade** Jonas Bendiksen surveyed the scene before him. It was July 2009, and he was in southern Bangladesh covering the flooded Ganges Delta for this month's "Big Melt" story. From the safety of a dry canoe, he watched displaced villagers wade through the dirty water as their possessions floated by. "It was really sad to see," he recalls. Bendiksen decided that to get the proper perspective, he should be in the water too. So he literally immersed himself in the assignment for four days. Some of his equipment perished along the way, but that mattered little to the Norwegian photographer. "What are you going to do?" he asks. "My camera might be broken, but these people are ecological refugees."

HOW TO HELP **Taking Action** Access to clean, fresh water is a pressing problem around the world. These are a few of the many groups that are trying to help.

■ **Water for People** programs improve drinking water in developing countries. waterforpeople.org

■ **Water Advocates** promotes water availability, sanitation, and hygiene. wateradvocates.org

■ **Population Services International** is involved in efforts against waterborne diseases. psi.org

■ **Global Water Challenge** is a coalition working for access to clean water. globalwaterchallenge.org

Society Updates



NEW BOOKS

Filmmaker Irena Salina brings together the voices of Bill McKibben, Sylvia Earle, and more in *Written in Water: Messages of Hope for Earth's Most Precious Resource* (\$26). It's in bookstores now.

Next month look for *Running Dry*, Jonathan Waterman's account of the Colorado River. He chronicles his 2008 trip from source to sea in this book that is at once an adventure saga and a cautionary tale (\$26).

ON TV

Test your knowledge of *National Geographic's* Water Issue when *Jeopardy!* features a category devoted to our April issue. Watch the week of March 29.

WORLD WATER DAY

Learn about efforts to solve the world's water problems during World Water Day, March 22. The National Geographic Society's Grosvenor Auditorium will host one Washington, D.C., event, beginning at 9:30 a.m.

GeoPuzzle Answers

A	D	E	L	S	T	L	V	O	N
A	G	R	E	U	T	E	S	A	T
M	O	H	E	R	B	E	R	I	T
O	P	T	I	N	F	A	N	T	
A	S	H	E	E	D	A	M		
D	E	A	T	H	E	L	I	N	E
S	E	L	A	V	I	L	A		
R	I	T	A	D	E	N	I	S	
G	A	S	M	E	I	R	V	I	D
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S	H	I	A	A	R	O			
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The Cool Kids Children seek a soaking outside a Connecticut firehouse in 1935. The unusual shower arrangement may have been rigged by local firefighters specially for summer refreshment. In towns big and small, options for larger scale (and even soggy) recreation increased greatly during the 1930s as government groups such as the Works Project Administration and the Civilian Conservation Corps put the Great Depression's unemployed to work. Their efforts included the construction of hundreds of swimming pools across the United States, many of which are still in use today. —Margaret G. Zackowitz

Flashback Archive Find all the photos at ngm.com.

PHOTO: LUIS MARDEN, NATIONAL GEOGRAPHIC STOCK

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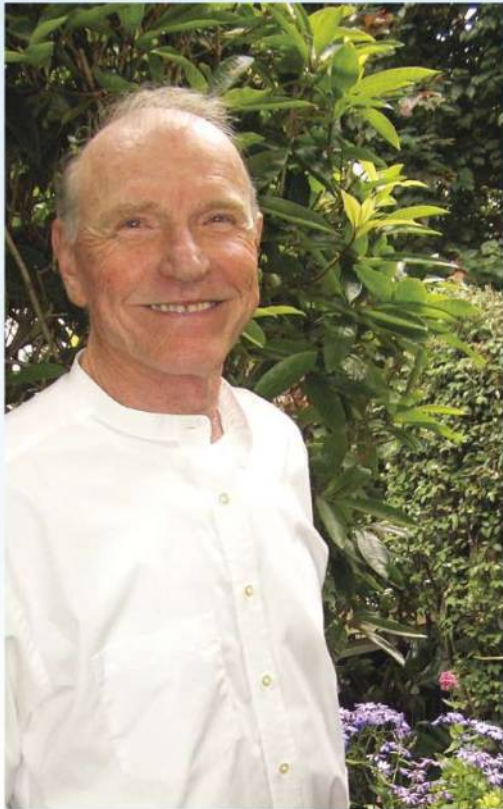


Inspire Future Generations

An avid traveler and horticulturist, John McCallister was introduced to National Geographic when his aunt sent him a gift subscription to the magazine in the 1940s. "I like everything about National Geographic, what it stands for, and what it accomplishes," John says.

Now retired, John spends his time taking continuing education classes, landscaping his garden, and frequenting art museums, theatre performances, and concerts. John made a bequest gift as a way to support the things he holds dear. "I included National Geographic in my will because I want the Society to be around for future generations," he says.

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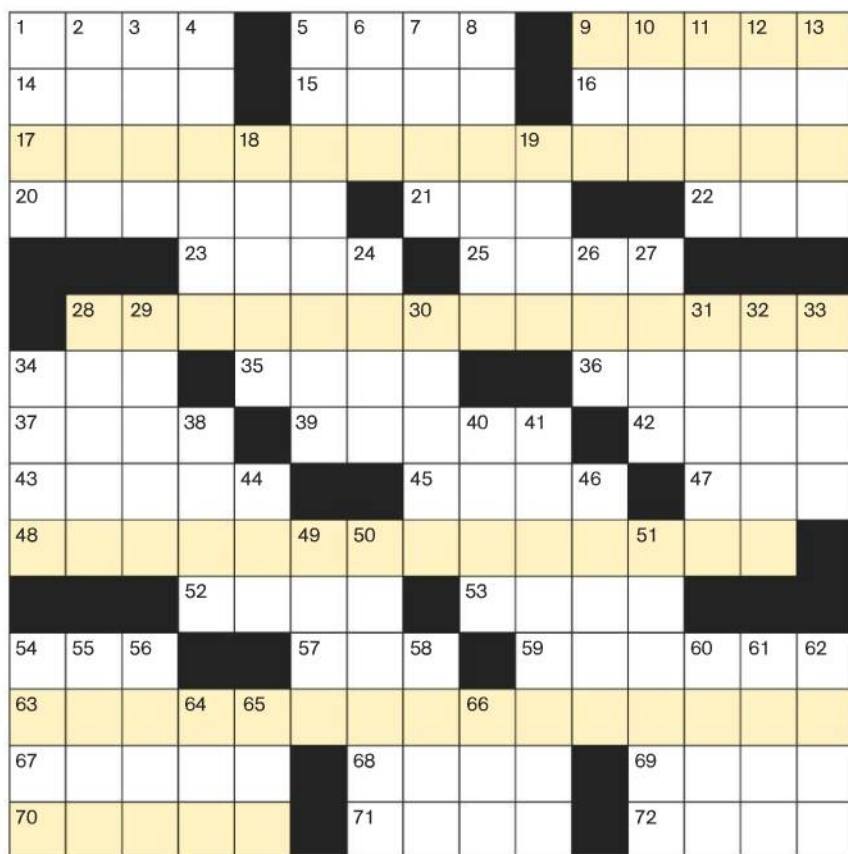
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GEOPUZZLE



DOWN

- 1 Doings, in the *Aeneid*
- 2 Sammy who gave us "High Hopes"
- 3 Thuringian three
- 4 Bungling
- 5 Unpopular
- 6 Granite State Sch.
- 7 Water behind a dam
- 8 Make beloved
- 9 Its waters aren't normally wild
- 10 Winnie-the-Pooh bird, by his own spelling
- 11 First name in scat
- 12 Util. bill component
- 13 Santa's delivery
- 18 Hebrew Bible book after Micah
- 19 Deviate
- 24 Play to ___ (draw)
- 26 Each of this puzzle's "wild" waters: abbr.
- 27 Groucho character ___ B. Driftwood
- 28 Easy to fool
- 29 Harbor of ancient Rome
- 30 Surrealist painter Max
- 31 Start of some Keats poems
- 32 Pee Wee biggie in baseball history
- 33 Fitted part of a garment
- 34 Alum
- 38 Utah ski resort
- 40 "Aren't ___ lucky one!"
- 41 Maximally squalid
- 44 They're heard during physicals
- 46 Backup strategy
- 49 Buckeye State
- 50 Trawler's amount
- 51 "Are you OK?" response
- 54 Sultanate on the Arabian Peninsula
- 55 Kind of stick that makes one jumpy?
- 56 Gang's region
- 58 Bus driver on *The Simpsons*
- 60 Just ___ (slightly)
- 61 Geeky person
- 62 Item under a round
- 64 It's often in hot water
- 65 Riled (up)
- 66 Jacks and toms, e.g.



Wild Waters

Puzzle by Cathy Allis

This young swimmer is no doubt feeling a bit out of whack as he braves the rushing waters of a canal off Tajikistan's Vakhsh River. If he were to dive into the GeoPuzzle, he might suffer a similar sensation when tackling the tinted clues.

ACROSS

- 1 OK in any outlet
- 5 Bamboozle
- 9 With 70 Across, Burns's title description of a guilt-free dessert?
- 14 Jung or Yastrzemski
- 15 Hip to
- 16 Chihuahua chicken
- 17 Where barefoot folks live, in New York State?
- 20 Zoo's who?
- 21 Victor at Fredericksburg
- 22 BTU producers
- 23 Major branch of Islam
- 25 Prefix with dynamic
- 28 Northern area where nary a chortle is allowed?
- 34 Nitrous oxide, for one
- 35 Rabin's predecessor
- 36 Caesar's "I see"
- 37 Singer Coolidge
- 39 Patron saint of France
- 42 Car radio button
- 43 Birthplace of St. Teresa
- 45 Dance bit
- 47 Verb suffix
- 48 Christie mystery about someone who waited way too long at the checkout?
- 52 Queens stadium named for court king Arthur
- 53 Red-coated cheese
- 54 Make a decision
- 57 "Trial of the century" judge
- 59 Cause of sleep deprivation
- 63 What an aggressive toddler's playmates should avoid?
- 67 See eye to eye
- 68 Salt Lake City hoopsters
- 69 Japan's first capital
- 70 See 9 Across
- 71 Bewildered
- 72 Circular current

**Answers in
Inside Geographic**

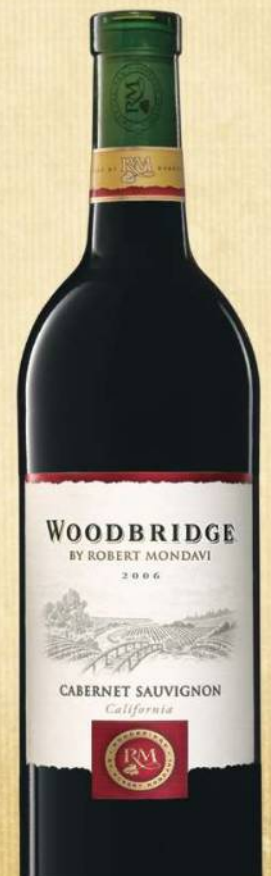


His dreams changed a valley.
His wines changed a country.

Robert Mondavi transformed Napa Valley, crafting wines that stand among the best in the world. Then he took all he knew to Woodbridge, CA, to make affordable wines for every day. Because every table deserves the joy of great wine.

His name is on the bottle. His story is in it.

WOODBRIDGE
by Robert Mondavi



Smarter business for a Smarter Planet:

Your data is trying to tell you something. Is your business built to hear it?

Businesses can't do away with risk. But on a smarter planet, can that risk be reduced? IBM is doing this with ORX, a consortium of 52 leading financial institutions that are pooling their anonymous data and using statistical modeling to more accurately assess their risk exposure. And the IBM Fraud and Abuse Management System is helping industries as diverse as insurance, healthcare and government sort through tens of millions of records in minutes, so they can identify, analyze and, ultimately, prevent fraudulent behavior. With more than 4,000 consultants and over 450 researchers and mathematicians who have deep expertise in business analytics, IBM is uniquely positioned to help companies use data to make better decisions and mitigate risk.

A smarter business needs smarter thinking.
Let's build a smarter planet. ibm.com/riskmanagement

